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The Engineer

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THE ENGINEER

A Seven-Day Journal

Metropolitan Water Board

AT the meeting of the Metropolitan Water Board held in London on Friday, June 27th, Mr. Hugh Franklin, the Chairman of the Works and Stores Committee, announced that the proposals before the Board for the extension of filtration, pumping and distribution are the largest single scheme that the Board has been asked to approve, amounting to £5,250,000 out of the £40,000,000 construction scheme which the Board has in hand. That figure involves an expenditure of approximately £3 million for filtration works, £1 million for pumping stations and pumping plant, and £1¼ million for new mains. When these works were first mooted in 1940 it was anticipated that they would not be required until the middle of the next decade, but owing to the unprecedented increase in the demand for water in the Board's area during the past year, the provision of these new works was now necessary for the maintenance of the current water supply. A year ago Mr. Franklin warned the Board, when moving a resolution asking the Ministry of Health for special priority in works construction, that it would be faced with a partial, if not a complete, breakdown in water supply if the works then planned were further delayed. Unfortunately, he said, the warning then given was an understatement, because the water demand early this month was such that there was a partial breakdown in the service, which no priority permits granted last year could have overcome. On Monday, June 2nd, the water supply in the Board's area reached a record of 426 million gallons, which was followed next day by a figure of 420 million gallons. Those figures were more than 60 million gallons a day in excess of the normal capacity of the Board's works. It was possible that the difficulties which occurred three weeks ago may have to be faced again during a period of hot weather, and possibly even at other times until the new works are brought into commission. Meanwhile, the public can help greatly by avoiding waste and the excess use of water in every possible manner.

Motor Industry Research Association

THE buildings and laboratories of the Motor Industry Research Association at the Great West Road, Brentford, were open for inspection on the afternoons of Thursday and Friday of last week, June 26th and 27th. Members and their friends were invited to see the work in progress and discuss with the staff automobile research problems. To many visitors this was the first opportunity of seeing the general activities of the Motor Industry Research Association, which comes under the ægis of the Department of Scientific and Industrial Research, and is maintained by subscriptions from the industry, supplemented by a grant from the Government through the D.S.I.R. It may be recalled that the Association was formed on January 1, 1946, taking over the premises and much of the work of the then Automobile Research Committee of the Institution of Automobile Engineers, which up to that date had been the central research organisation serving the motor industry. We noted that good progress had been made with many of the researches. In the electronics laboratory the technique of strain measurement by wire resistance strain gauges has been developed, and interesting records have been obtained of stresses in vehicle frames, under running conditions. Another interesting strain gauge was to be seen built into the connecting-rod of a bearing testing machine. In this case the principle is that of an electrical condenser, two flanges in the connecting-rod being arranged to form condenser plates with an adjustable air gap. With the air gap adjusted to a small value an appreciable change in capacity results from a small change of loading.

Scientific and Technical Manpower

IN reply to a question to the Minister of Labour in the House of Commons on Wednesday, June 25th, as to the probable future demands of Government Departments, industrial research and teaching establishments upon the scientific and technical manpower of the country, Mr. Ness Edwards stated that Lord Hankey had agreed that inquiries to that end should be instituted by the Technical Personnel Committee which during the war performed valuable service in assessing the demand and supply of scientific and technical manpower. The inquiries were, he said, being conducted by specially appointed panels representative of all the interests concerned, and it was hoped that the results would be published in due course. At the request of the Advisory Council on Scientific Policy, which, we may recall, was recently appointed by the Lord President of the Council, under the chairmanship of Sir Henry Tizard, a further survey of existing manpower in the country in the fields of science and professional engineering is to be made. This survey will be carried out by the Technical and Scientific Branch of the Ministry of Labour, together with the assistance of the appropriate scientific bodies and professional institutions.

North of Scotland Hydro-Electric Distribution Schemes

THE North of Scotland Hydro-Electric Board has just announced schemes for the distribution of electricity in the Ullapool district of Ross-shire and the islands of Lewis, Islay and Shetland. In approving these schemes, the Electricity Commissioners have said that they will give financial sanction for partial developments in the first place, permitting the Board to proceed with a first stage of each scheme. The scheme for the Island of Lewis will eventually cover the whole island and the Board proposes to go ahead with a first instalment covering the Eye Peninsula and North Tolsta. In Shetland it is proposed as a first step to extend the Board's distribution line across the mainland from Lerwick to Scalloway. In Islay the Board has bought a small diesel engine power station at Bowmore from the Air Ministry, and it is proposed to provide supplies in the first place from Bridgend in the one direction to Port Ellen in the other. At Ullapool the existing small generating station has been acquired. Diesel engine generating plant of increased capacity will be installed to give better supplies in the village and to provide for any local industries. The Board is anxious to extend supplies to the full in all four schemes as soon as financial authority can be obtained and the extreme shortage of materials can be overcome.

Further Oil Engine Industry Rationalisation

ON Tuesday, July 1st, it was announced that J. and H. McLaren, Ltd., of Leeds, is to take over the oil engine business of John Fowler and Co. (Leeds), Ltd., and that the existing commitments of the Fowler concern will be met by Associated British Oil Engines, Ltd. In our issue of January 17th we announced the merging of the Fowler business with that of Marshall, Sons and Co., Ltd., of Gainsborough, with the intention of extending the production of Field-Marshall heavy wheel tractors. In order to provide the necessary production facilities and to achieve concentration on this objective, an agreement has now been made between John Fowler and Co. (Leeds), Ltd., and Associated British Engineering, Ltd., whereby the latter named company will acquire the whole of the goodwill, including the stock in trade and work in progress of the oil engine section of John Fowler. We may recall that the internal combustion engine products of the Associated British Engineering group of companies are sold by Associated British Oil Engines, Ltd., and its subsidiary export company, British Oil Engines (Export), Ltd., which are the sole concessionnaires for Mirrlees, Petter, Cub, Petter-Fielding and McLaren. In due course the engines that will be manufactured by John Fowler and Co. (Leeds), Ltd., will be those specially required for installation in those products of the Marshall group which are based on the Field-Marshall tractor engine. In view of the agreement above named, Fowler industrial engines are not being exhibited on the Marshall-Fowler stand at the Royal Show at Lincoln.

The International Railway Congress

SOME 500 delegates were present at the fourteenth session of the International Railway Congress, which was held at Lucerne from June 23rd to 28th. Government delegates attended from Belgium, China, Czechoslovakia, Denmark, France, Great Britain and India, Hungary, Italy, Jugoslavia, Luxembourg, Norway, the Netherlands, Poland, Portugal, Spain, Sweden and Switzerland. Also present were delegates from railway administrations in Argentina, Austria, Belgium, Bulgaria, Burma, Ceylon, China, Czechoslovakia, Denmark, Egypt, Finland, France and Colonies, Great Britain, Greece, Hungary, India, Iraq, Italy, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, South Africa, Sudan, Sweden, Switzerland, Turkey, and the United States. The first day of the Congress was occupied by formal business and a reception by the Permanent Commission. The proceedings were conducted in five sections, each of which discussed reports presented on specific questions. The first meeting was held on Tuesday, June 24th, and was followed by morning meetings on the two subsequent days. A report to the Ways and Works Section dealt with types of sleepers and sleeper maintenance. It covered the views expressed by some twenty-four managements, dealing with a total track length of more than 121,300 miles. In the Locomotive and Rolling Stock Section a survey was given on the different methods used in various countries to reduce the dead weight of rolling stock. It showed a general agreement that the design and adoption of lighter rolling stock is both desirable and feasible. Other reports presented dealt with an investigation into the various aspects of economic and efficient passenger train working, and the provision of housing accommodation by railways for their employees. A series of visits and excursions arranged for the delegates extended for some days after the Congress.

Conversion of Red Rock Mill, Canada

THE sulphite mill of the Brompton Pulp and Paper Company at Red Rock, Ontario, Canada, has been completely rebuilt for the manufacture of bleached kraft pulp and kraft liner board. At present it has a capacity of 200 tons per day. It is a matter of no little interest that this elaborate conversion programme was begun while war still raged and in the face of such difficulties as material and labour shortages.

The Brompton Pulp and Paper Company adopted a ten-year plan of rehabilitation of its mills at East Angus, Quebec, which was carried on through the depression years of the past decade. On completion of this programme, which involved expenditures of 1,119,291 dollars, the company acquired the properties of the Lake Sulphite Company, Ltd., in 1942. These properties included extensive timber limits on the Nipigon watershed, a groundwood mill at Nipigon, and the dock and buildings of a bleached sulphite pulp mill at Red Rock.

The project undertaken was to convert this substantial structure into an integrated mill to produce sulphate pulp and various grades of kraft liner and corrugating boards and to complete the development of a modern town, Red Rock, in an attractive setting for a fine community, about sixty miles east of Port Arthur. Red Rock is on the Trans-Canada Highway and on both the Canadian Pacific and Canadian National Railways.

Wood deliveries from the Nipigon watershed pass through Lake Helen just above the town and are made up into rafts on Nipigon Bay and towed to the Nipigon and Red Rock Mills. The wood handling begins at the wharf, the waters having been dredged so that vessels of 10,000 tons capacity can be accommodated. There is a spur rail line the entire length of the wharf to facilitate loading and unloading vessels. The log booms are moved into position for the haul-up by 20 h.p. diesel winch boats.

The logs arrive mainly in 8ft lengths and three saws in the slasher cut them into 4ft logs. The sawdust which falls from the slasher is taken on a conveyor to a hopper, where trucks take it to a storage pile. The logs drop on to a log lugger conveyor and are sent to the wood room, where they are guided to the mouth of barking drums on a rubber conveyor belt. Horton barking drums tumble the logs until the bark is removed; then they are carried on a Jeffrey rubber belt conveyor to a ten-knife chipper. A link belt bracket elevator carries the chips to two Dillon vibrating screens, from which the oversized chips drop into a swinging hammer hog and the finer pieces are returned to the screen. The accepted chips are carried on a rubber conveyor and can be dumped in any section of a bin.

A log storage pile is kept outside for use in winter, and a Northwest crane with an orange peel grab attachment is used to load the logs from the piles on to portable conveyors. Pulpwood arriving by rail is scaled at the mill.

RED ROCK PULP AND PAPER MILL

Sulphate Pulp Mill

In general terms, the sulphate pulp mill processes are as follows: Leaving the bins, the chips are conveyed to four digesters and cooking begins, using white liquor and black liquor. When the cook is finished at a chlorine number of 11, the stock is blown into a blow tank, from which the waste vapours and steam escape through a vent in the top into an adjoining tank, for storing this contaminated hot water. This water is sent through a Rosenblad heat exchanger to meet incoming fresh, cold water, which goes then to a storage tank and eventually is used for washing purposes on the pulp washer.

The pulp in the blow tank is pumped directly to two Swenson-Nyman two-stage vacuum washers, where it is first mixed with black liquor, then subjected to a weak black liquor spray, and finally washed with hot water before being sent to the brown stock chest. In the meantime, the filtrate from the washers goes to the weak black liquor storage tank, and from there goes to evaporators. Meanwhile, pulp in the brown stock chest is continuously agitated and is sent to three Jonsson knotter screens which are situated beside the two washers. These screens separate the knots and large fibre bundles from the accepted stock. The rejected stock is washed to a Jeffrey breaker before going to four Trimbley fine screens. The accepted stock goes to two Swenson-Nyman vacuum deckers and from there to the two stock chests, which are kept in constant flux by means of agitators.

Referring to the Jonsson screens again for a moment, the accepted stock goes directly to four Trimbley fine screens and thence as above through the vacuum deckers and to the stock chest, from which it is sent to the paper machine. The rejected stock from the fine screens is fed to a Trimbley tailings screen and the accepted stock from this screen is fed to the deckers. The decker filtrate goes directly to a white water wooden storage tank and is eventually used in showers and as diluent for the washers, knotters and screens.

The oversize knots and slivers are fed to the breaker and the resultant large fibres and the rejects from the tailings screen are pumped to a tailings tank of wooden construction, capable of holding 3800 gallons. From here, the tailings are pumped to a coarse screen, and the rough stock is sent to a Canadian Ingersoll-Rand Haug refiner, leather-belt driven from a 75 h.p. Commonwealth motor. From this refiner, the stock goes to a refined stock tank and thence returns to the Jonsson screens again.

Following are a few details of this pulping, washing and screening process, beginning at the chip bin. The rubber belt conveyor used to carry the chips from the bin to the digester runs alongside and a few feet below the chip bin floor level. The chips are drawn from the bin on to the conveyor by the screws of a twin-screw chip feeder, which projects into the bin. This machine runs on tracks directly over the conveyor and extending the entire bin length.

The chip conveyor is run only when a digester is to be filled, as the chips are directly emptied into a conical hopper atop the four digesters. By means of the swivel spout of the hopper, the chips are emptied directly into the proper digester.

Cooking liquor is added at the same time.

A Foxboro digester liquor measuring system is used. The required volume of white and black liquor for each digester is determined by control tests and this volume of liquor is automatically measured and then pumped into the digester by the Foxboro control system. This system consists of liquid level gauges and Nordstrom air-operated valves on the white and black liquor measuring tanks. In this way a complete record is available of the liquor charge put into every digester.

The digesters, of Dominion Bridge manufacture, are of welded steel construction and are grouped in a square, one at each corner. The blow tank and the contaminated hot water tank are sulphite digesters originally installed by the Lake Sulphite Company. The blow tank is fitted with an arm agitator, the shaft passing through the bottom of the tank and being driven by a Commonwealth motor through a Cleveland reducing gear unit.

There are two accepted stock storage chests. These chests were originally installed by the Lake Sulphite Company for use as blow tanks and are of concrete construction with two baffles installed by Brompton. The stock is circulated by a propeller agitator and is then pumped to the paper machine.

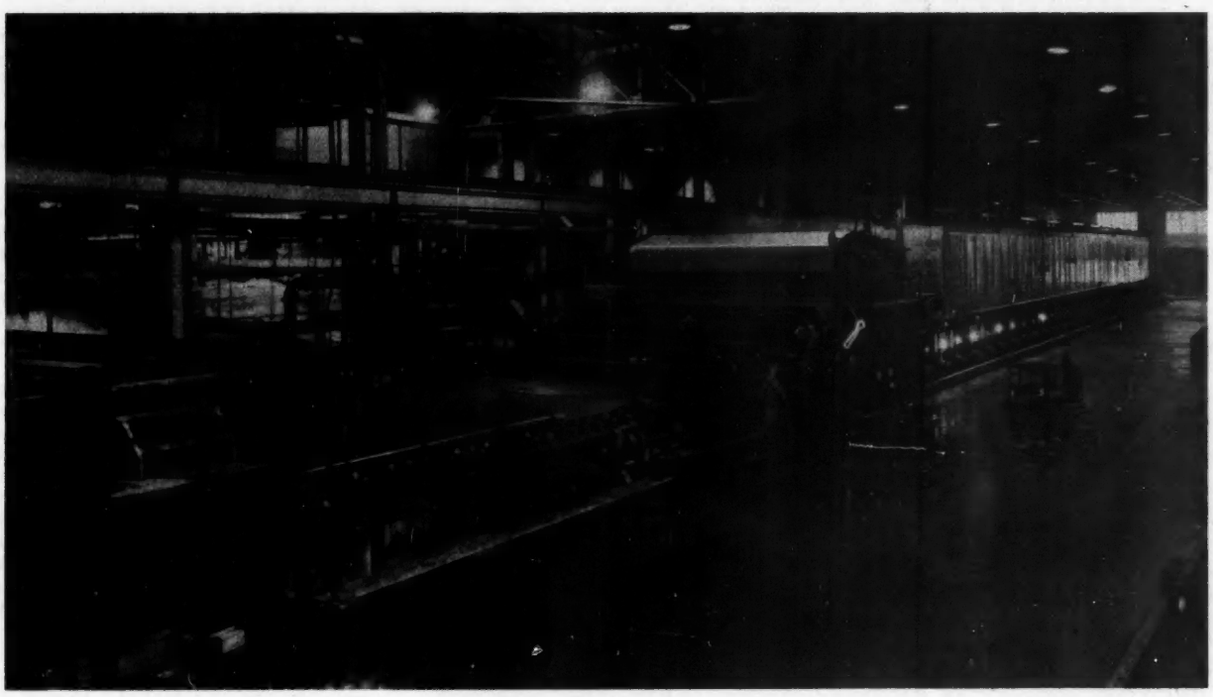
The Paper Mill

The paper mill is housed in a large, well ventilated building flanked on one side by a raw materials storeroom and on the other by the finishing and shipping room. All accessory equipment, with the exception of the breaker beater in the basement, is on the same level as the paper machine; first come the refiners, then the save-all, consistency regulator, size tank and alum tank, all in a row; then comes the paper machine, flanked by the drive, air conditioning unit and economisers.

To follow the pulp on its journey to become kraft liner and kraft corrugating board, one must go to the stock chest in the pulp mill. This stock is pumped at a consistency of 3·25–3·50 per cent to the refiner chest. Size is added to the stock in this chest—the quantity of size being regulated by a Rotameter. This refiner chest, made of concrete, has a capacity of approximately six tons of pulp. From here, the stock is pumped through four Sutherland refiners, illustrated herewith, which are connected in parallel. Each refiner is driven by a 350 h.p., 450 r.p.m. Westinghouse motor.

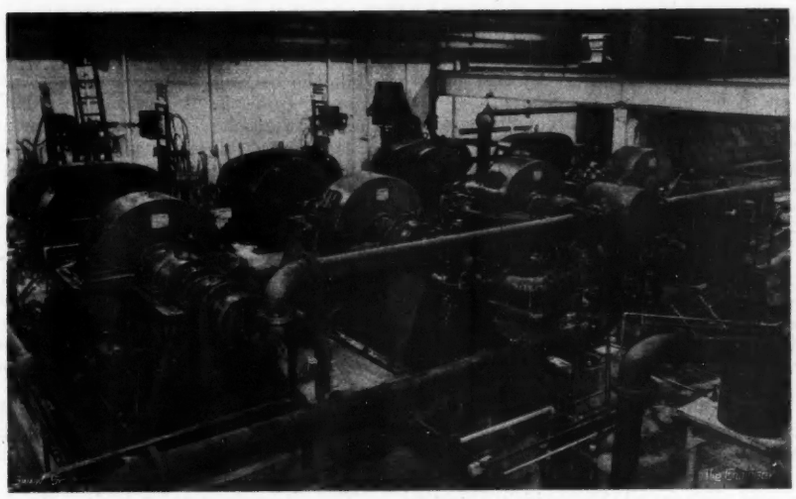
From the refiners, the stock flows to the machine chest, which has a capacity of approximately two tons of stock, and is of concrete construction, the stock being constantly agitated. From there, the stock is pumped to a Bird consistency regulator, which maintains the consistency at 3 per cent and the stock is pumped to the stock meter at the stuff box. At this point, alum is added and the stock then goes to the head box of the paper machine, at a *pH* of 6.

The Walmsley paper machine, illustrated herewith, was originally installed at Bromptonville, Quebec, in 1926, and produced newsprint at that plant until the company decided on the Red Rock construction.



REBUILT WALMSLEY PAPER MILL

At that time, this machine was dismantled and rebuilt by Dominion Engineering for kraft production and shipped to Red Rock and reassembled. Some of the rebuilding job entailed the lengthening of the wire from 75ft to 90ft, the addition of several dryers, and the installation of a Midwest Fulton dryer drainage system. The machine width is 234in, with a trim of 222in. A 50-mesh wire is used. A dual press section is attached—the paper goes through the first suction press, then to the second suction press before going over the smoothing roll and thence to the dryers, of which there



GROUP OF SUTHERLAND REFINERS

are four sections, totalling 58 rolls, 10 being felt dryers. The speed of the machine is 650ft per minute on 0·009in kraft corrugating board and 350ft per minute on 0·016in liner board. Eventually this speed will be increased to 750ft per minute for corrugating and 400ft per minute for liner. The production at present is 200 tons per day, but it will be increased to 260 tons when the machine goes on increased speeds. The machine is driven by a Harland sectional electric drive—each dryer section forming a separate unit, but the whole alternatively controlled by a single switch.

The suction on the couch roll is applied by a 14in Nash Hytor vacuum pump, while an 8in Nash vacuum pump applies the suction on the nine suction boxes which are coupled to waterlegs. On the liner board operation, a shake is imparted to the wire by means of a Dominion Engineering shake mechanism. Another installation to be made on the machine will be that of two Vickery felt conditioners for washing the press felts.

The Ross-Grewin system, installed on the dryers, forces air through a steam heating coil (25 lb pressure); this air in turn is piped to the paper machine and blown at a temperature of 190 deg. between each pair of dryers to remove vapour pockets. The four economisers were installed by Ross Engineering and are complementary to the Ross-Grewin system.

Stock is fed to the wire at a consistency of approximately 0·440 per cent, depending on the grade of paper. Wire pit white water flows back to the water make-up fan pump and the couch pit waste is pumped by means of an Allis-Chalmers vertical pump to the save-all, from which it goes to the broke chest and thence to the refiner chest. Running overhead for the entire length of the paper machine is a 30-ton Morris travelling crane, used chiefly in changing of wires.

At the dry end there are two calender stacks. The first is called the water stack, and it is at the water box of this stack that paraffin wax and starch is added to give a water finish to the paper; the second stack gives the finish to the board, usually three nips being used.

The Walmsley winder is to be rebuilt. At present it is capable of a speed of 2800ft per minute, but when rebuilt it will be in a position to make rolls up to 55in diameter. A new Cameron rewinder, capable of handling 55in diameter rolls, has also recently been installed in the machine room.

The broke disposal system is so arranged that there is never any piling up of broke on the machine floor or around the broke beater in the basement. The broke beater installation is directly under the stacks and winders; broke is dumped from the machine room directly into the beater itself. The beater layout is T-shaped, the stock cycle following the outer borders of the "T" until it returns to the starting point. Stock is kept in circulation by two Waterous feeder rolls situated at opposite corners, while the beating is done by a Dilts beater brought from the Bromptonville mill. As the broke reaches the proper consistency, it is pumped to the machine chest by a Canadian Allis-Chalmers vertical pump.

550-VOLT GEAR IN SUB-STATION

STEAM PLANT

Steam is generated in the Red Rock plant by means of two Combustion Engineering VU type pulverised fuel boilers, as well as a black liquor recovery Combustion Engineering boiler. The two pulverised coal boilers together consume 75 tons of coal per day and each generates 775 boiler horsepower; they have 7742 square feet of heating surface, and are rated each at 50,000 lb of steam per hour. Each works at a steam pressure of 175 lb, and a total steam temperature of 447 deg. Fah.

The coal necessary for feeding the steam plant is unloaded from boats into a hopper on the wharf, from which it is dropped on to a Stephens-Adamson apron feeder, whence it is conveyed by a rubber belt conveyor to the stock pile. When coal is required by the steam plant, it is reclaimed from the pile by a bulldozer and supplied to a hopper feeding a Jeffrey crusher. Thence, it goes by belt conveyor to the steam plant bunkers mounted directly over the two pulverisers.

From the bin the coal is weighed before being dropped into the Raymond bowl pulveriser of each boiler unit. Each pulveriser is operated by a 75 h.p. Canadian General Electric motor. The pulverised coal is blown by a Raymond exhauster fan into the furnace proper. In each boiler unit the various motors driving the pulverisers, blowers, induced draught fan and forced draught fan are interlocked so that failure of the induced draught fan motor will automatically shut down the entire unit.

Water for the boilers is pumped from Lake Superior and before being used is treated in a hot lime and soda softening system. This softening process comprises filtering in a Cochrane pressure filter and passing the filtrate through a Cochrane deaerating heater to raise the temperature to 220 deg. Fah. A Hall water conditioning system is used and Hagen phosphate is injected into the feed pump suction. Steam generated goes to a common header and one line goes to the paper mill, the other two to the pulp mill.

All three boilers have a Cochrane continuous bleed system which bleeds off a portion of the boiler water, the steam from which goes to a flash tank. Here the steam flashes off at 5 lb pressure and goes to the feed water heating system. The remaining hot dirty water in the flash tank flows to the sewer, first passing through a heat exhanger, thus heating up the incoming raw make-up water from the lake. A special Hancock micrometer valve controls this bleed, as required by the boiler water concentration.

A United conveyor ash disposal system is in use at this plant. The furnace ashes are blown out by means of a vacuum steam ejector to a receiver just outside the boiler house building; then the ashes are dropped to a hopper, whence they can be unloaded on to a truck for disposal.

Each boiler is equipped with a fuel oil lighting-off system, whereby a fine spray of burning fuel oil is injected into the furnace until the ignition temperature of coal is reached; the pulveriser is then started and coal introduced. The fuel-air temperature is 180 deg. Fah. A plate air preheater is used to maintain an air temperature of 340 deg. Fah.

The paper machine condensate is returned to a hot well in the boiler house and is then pumped directly to the feed water heater and thence into the boiler, thus by-passing the chemical treatment.

The steam plant staff is responsible for supervising the steam generating part of the black liquor recovery boiler, and engineers are on duty each shift in the recovery plant for that purpose.

ELECTRICAL DEPARTMENT

Power for the Red Rock Mill is supplied from the Cameron Falls plant of the Ontario Hydro-Electric Power Commission, 15 miles up the Nipigon River. The incoming 121,000-V lines feed three 4000-kVA single-phase Westinghouse transformers, controlled by a Westinghouse oil circuit breaker, stepping down the voltage to 2300V. Current at this voltage is supplied to an eight circuit Bepco panel with Crompton Parkinson controls in the substation, with switching arrangement for auxiliary power. Included in this switchgear there is an oil circuit breaker controlling three 1667-kVA single-phase Canadian General Electric transformers, stepping down 2300V to 550V for supplying power to all the motors up to 75 h.p., through a bank of 12 AL Canadian General Electric circuit breakers. All motors over 75 h.p. are fed from the

2300-V panel board. All synchronous motors have a leading power factor of 0·8. An accompanying illustration shows the 550-V panel; this switching room is provided with aluminium busbars.

A majority of the large motors used throughout the mill are Westinghouse, with Westinghouse panels. Totally enclosed Commonwealth motors are used in wet areas of the mill areas, such as the slasher, digester room and screen room. In wet areas also some Canadian General Electric protected type motors are used.

The paper machine is operated by Harland sectional electric drive with a 500 h.p. 2300-V motor driving the d.c. generator. This motor is a temporary arrangement, owing to the failure of the steam turbine which formerly drove the d.c. generator. The Nash vacuum pumps in the machine room are driven by an Allis-Chalmers Bullock 500 h.p. motor. This motor, too, is a temporary measure, due to the failure of the above-mentioned steam turbine, which formerly operated the suction pumps.

Finishing and Shipping

The finishing and shipping department, situated between the paper machine and the railway car siding, is conveniently placed to carry out its duties with the least amount of lost time. The necessary markings are placed on the rolls at the machine and the rolls are then transported into the finishing department by sliding them on a track for gluing and weighing on a Canadian Fairbanks-Morse beam scale. After weighing, the rolls are picked up by an automatic electric lift truck and loaded into freight cars. The lift truck can pile rolls up to a height of three tiers and hence is almost capable of loading a car single-handed. Each roll is braced by wooden blocks, and when the car is completely loaded the entire cargo is encircled by two bands of steel strapping, using an Acme machine for fastening the seals. The steel strapping used is ¾in wide and 0·035in thick.

This department also sees that the paper machine is kept well supplied with the correct size paper cores on which the kraft paper is wound. These non-returnable cores are purchased from outside sources and are cut to size in the mill. Roll widths vary from 24in to 84in. At present it is possible to load five cars of paper per eight-hour shift and in that connection it might be mentioned that the employees in the car-loading section work two shifts, while the weighers and wrappers work the three regular shifts.

The same building acts also as storehouse for any paper rolls that may be awaiting completion of an order, this paper being stored into piles by the above-mentioned lift truck.

The Royal Show at Lincoln

No. I

THE first post-war show organised by the Royal Agricultural Society of England opened at Lincoln, under the Presidency of Lieut.-Colonel Sir Archibald Weigall, Bart., on Tuesday last, July 1st, and closes to-day, Friday. Although some months ago it was stated that this year's "Royal" would be rather on "austerity" lines, the variety and extent of the exhibits have undoubtedly brought it very near to the excellence of its predecessors.

The first Royal Show was held on a seven-acre site at Oxford, in July, 1839, and it is of interest to recall that as well as livestock exhibits there was a display of agricultural implements and also some implement trials were held.

The implement section has been an important feature of every succeeding Royal Show, and on the occasion of the last Show—held at Windsor in July, 1939, under the Presidency of H.M. The King—there were 430 stands, in 1¾ miles of shedding, for the display of agricultural implements and machinery. This year at Lincoln there are 425 stands, containing a big variety of machinery, ranging from items of power-driven equipment required for extensive arable farms, down to the simpler tools used on small holdings. Many of the exhibits are indicative of the developments that have been made in the war years, a matter which is emphasised by the fact that no less than sixty-two entries were made in the Royal Agricultural Society's Silver Medal competition for new implements. Twice before, in 1854 and in 1907, the Royal Show has been held at Lincoln. This year the site occupied provides an area of 100 acres.

In what follows we begin a description of some of the machines and implements which are exhibited.

John Allen and Sons (Oxford), Ltd.

Intended to fill the gap between the lawn mower and the ordinary agricultural mowing machine, a self-propelled motor scythe, designed and produced by John Allen and Sons (Oxford), Ltd., of Cowley, Oxford, is a robustly built tool for cutting rough growths, reeds, brambles or cultivated crops of many kinds. The accompanying sectional view, Fig. 1, indicates the construction of the machine. Briefly, it is balanced about and runs on two rubber-tyred disc wheels, which can pass freely over cut material, and has in front a power-driven reciprocating cutter, 3ft wide, with knives of the conventional pattern, of which the fingers can easily be sharpened with the ordinary reaper file. The machine is controlled and steered by the operator, who walks gripping two handlebars at the rear.

Power for propulsion and the cutter bar is supplied by a 1½ h.p. two-stroke 147ccm Villiers engine, with governor control and forced air cooling. From the engine power is transmitted through constant-mesh gearing in an oil bath gear case, and a clutch to a worm shaft which meshes with a worm wheel on the driving axle. On the front end of the worm shaft is a crank and die mechanism, which imparts an oscillating motion to a spring steel bar, of which the front end is attached to the cutter bar. The clutch, which is of the disc pattern, is spring-loaded and arranged to slip if a solid obstacle is encountered whilst cutting. Two simple controls, clutch and throttle, are fitted, one on each handlebar. The throttle is used to vary the speed of the machine, and the clutch permits the drive to the wheels to be disconnected at will.

The cutting mechanism on the standard machine is placed centrally, but an alternative knife bar can be supplied, providing for offset cutting to the left of the machine or to the right. By removing three bolts, the finger bar may be removed and replaced in any of the three positions, central, offset to the right or offset to the left, and the appropriate knife bar inserted. In each case the width of cut taken is 36in. Swath boards can be supplied, but can be fitted only to the offset cutting mechanism.

It is pointed out by the firm that all rotating parts are fully enclosed, with gearing in oil baths, so that dirt cannot penetrate, and, perhaps equally important, there are no external rotating parts to become clogged with cut material. The only exposed part of the cutter drive is a heavy steel spring, which throws aside the cut material and retains the cutter blades in close contact with the fingers. The petrol engine is stated to be of ample power to propel the machine up steep slopes and uneven ground without effort on the part of the operator. It is said that on the average the machine can cut 1 acre in two hours with a fuel consumption of about ½ gallon.

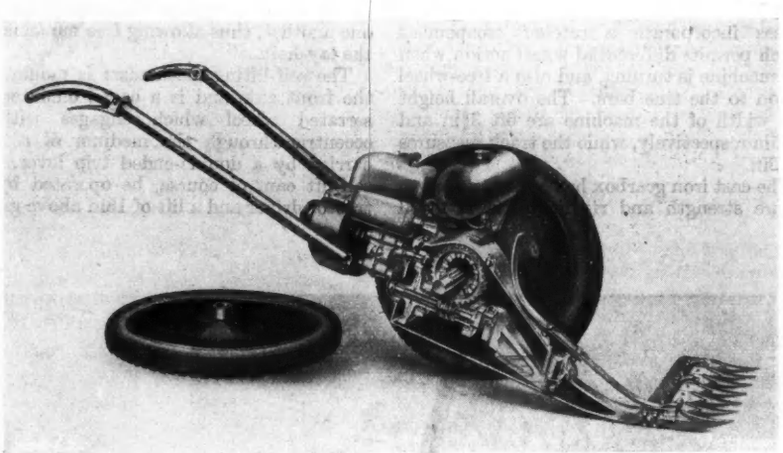


Fig. 1—Motor Scythe—J. Allen

On the firm's stand at the Show the "Allen" motor scythe is shown, together with some handy attachments, such as a high-pressure

spray pump, which can be fitted in place of the cutter bar, making the machine a self-propelled sprayer ; a light hoe ; and a trailer and tank.

R. A. Lister and Co., Ltd., and Blackstone and Co., Ltd.

One of the principal exhibits on the stand occupied by R. A. Lister and Co., Ltd., and Blackstone and Co., Ltd., is the Lister Blackstone combine haymaker, which was entered for the Royal Agricultural Society's Silver Medal Competition. The machine, which is illustrated in the engraving, Fig. 2, is the outcome of several season's exhaustive tests, and can be employed for tedding, side raking or swath turning. It is claimed for this three-purpose implement that the adjustments necessary to pass from one operation to another are simple and speedy.

The frame, which is rigidly built, comprises four main light steel members of angle section, supported on three wheels, two of the "carriage" type on the front axle, and a rear wheel of the castor type. The two front wheel bosses incorporate a ratchet escapement which permits differential wheel action when the machine is turning, and also a free-wheel action to the tine bars. The overall height and width of the machine are 6ft 3¾in and 9ft 5in respectively, while the track measures 7ft 5in.

The cast iron gearbox has been designed to ensure strength and rigidity, and is fitted with an easily removable inspection cover. It is mounted on the front axle, so that it is free from the frame and can rotate about the axle when the tines are lifted. The crown wheel, which is also of cast iron, has two bevelled tooth rings cast on one side which engage with two independent pinions freely mounted on the layshaft. The layshaft is at right angles to the front axle and is offset to cross directly above it. Either one or other of the pinions is engaged by means of the gear-operating lever and a sliding sleeve, so that the motion is transmitted through one of the pinions to the layshaft. The gear-operating lever has three locating points—tedding, neutral, and side raking and swath turning.

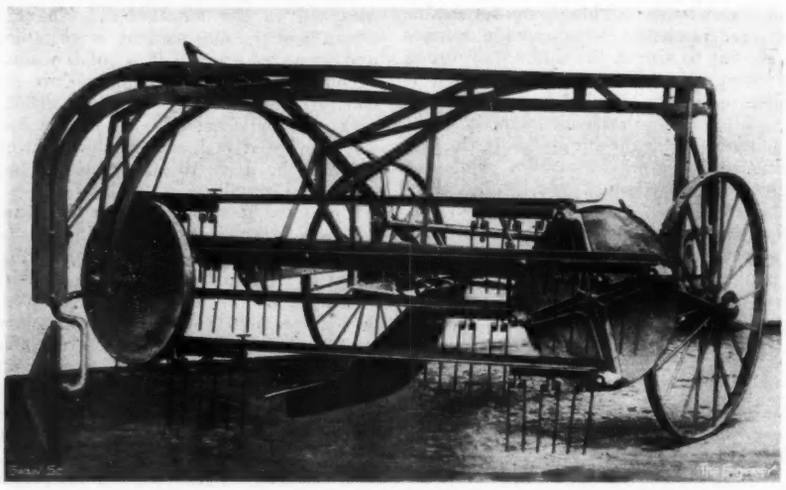


Fig. 2—Tractor Combine Haymaker—Lister Blackstone

In order to prevent damage to the driving gears, should the fliers be stopped by some obstruction, a slip clutch is mounted on the layshaft. It consists of hardened steel dogs having obtuse angled teeth cut in the faces, the teeth being held together by a helical spring. If obstruction is encountered, the spring is compressed and the teeth ride over one another, thus allowing free movement to the layshaft.

The self-lifting mechanism is mounted on the front axle and is a cast iron internally serrated wheel which engages with an eccentric through the medium of a roller carried by a double-ended trip lever. The self-lift can, of course, be operated by the tractor driver and a lift of 18in above ground level may be obtained whatever the setting of the tines. The tine bars are of mild steel angle construction, and are each fitted with twelve spring tines designed so as to adjust themselves to uneven ground. The desired setting is achieved by adjusting a hand-operated screw placed in the centre of the machine above the front axle. A view of the self-lift mechanism and this tine-setting screw is reproduced in Fig. 5. A stripper board constructed of specially bonded plywood is sheathed with steel sheet which provides a clean smooth surface to avoid collection of hay.

The designers of the combine haymaker have paid particular attention to lubrication. All bearing surfaces are grease-gun lubricated, and a feature of the gearbox is the lubricating panel on which five lubricating points are centralised, covering the whole gearbox assembly. The gearbox also has a filler cap and an oil level plug, so that the oil level may be correctly maintained.

The other exhibits on this stand include a range of oil and petrol engines, various pumping sets, sheep-shearing and cattle-clipping machinery, and a representative selection of dairy equipment. There is also shown an

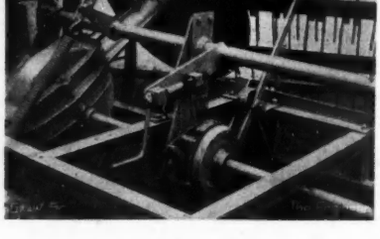


Fig. 5—Self-Lift Mechanism of Combine Haymaker—Lister Blackstone

example of the Todd insecticidal fog applicator, made by the Lister-Todd Engineering Corporation, Ltd. It is a fog-generating apparatus which produces a dense fog impregnated with minute particles of insecticide or other chemical agent dissolved or suspended in oil or water. The size of the fog particle may be regulated, the range of selection being from ½ to 60 microns. The apparatus can also be used for the application of hormones in the selective destruction of weeds amongst growing crops.

Harry Ferguson, Ltd.

Many advantages are claimed for the "unit" principle for tractor-drawn agri-

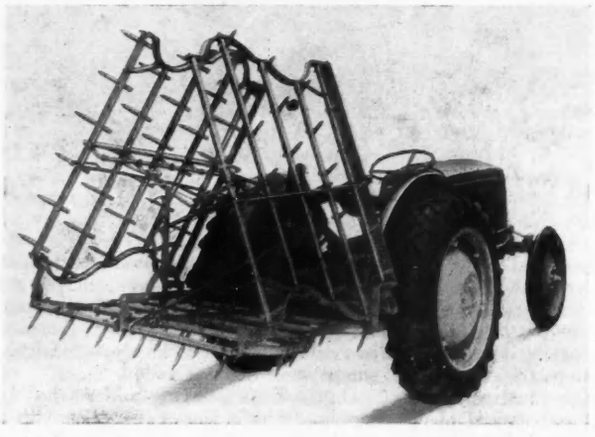


Fig. 3—Tractor and Spike Tooth Harrow Unit—Ferguson

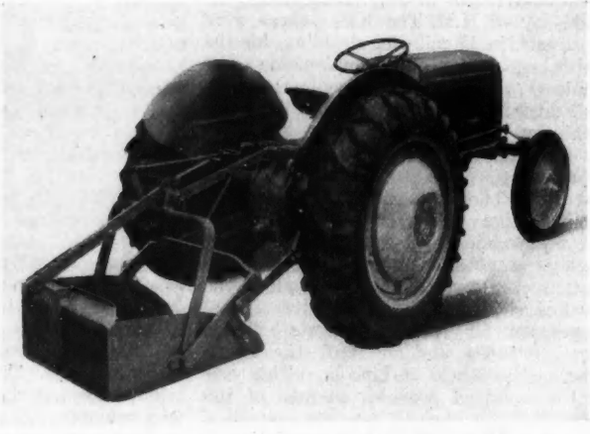


Fig. 4—Tractor and Earth Scoop Unit—Ferguson

cultural implements. The system usually embodies on the tractor a hydraulic lifting arm, controlled by a small lever and operated by a hydraulic pump driven by the tractor engine. Implements, instead of being towed as trailers, are carried by the tractor through an adjustable three-point linkage and are lifted clear of the ground when required by the hydraulic lift. When the hydraulic lift is lowered, the implement drops to a preset level, so as to obtain a constant working depth. The system lends itself to the attachment of numerous types of implement.

Briefly, the advantages are that, because of the short overall length of tractor and implement unit, much less space is required for headlands; the weight distribution is such that the adhesion of the tractor driving wheels is generally improved, and an even working depth is maintained when the implement is at work; and, above all, it is convenient and speedy in use.

Tractors and implements of this type built by Harry Ferguson, Ltd., of Coventry, are on view at the Show, and by way of illustration, we reproduce in Fig. 3 a view of the spike tooth harrow attached to the Ferguson tractor. The harrow is made in three parts, arranged to fold so that it may pass through gates and narrow openings. Our engraving shows the implement in the raised or travelling position. Other implements produced for the Ferguson "unit" system include a two-furrow plough, a three-row ridger, a disc harrow, a rigid tine row crop cultivator, a mowing machine, a transport box, and an earth scoop and a trailer. In Fig. 4 is shown the earth scoop. This view also illustrates the method of attachment of implements.

The Ferguson tractor is petrol driven, with a wet-sleeve four-cylinder engine of $3\frac{5}{16}$in bore and $3\frac{3}{4}$in stroke. At the power take-off it is designed to give a maximum power of 23·9 b.h.p. and it is capable of pulling a two or three-furrow plough. The governor can be regulated for speeds between 400 and 2000 r.p.m. With engine revolving at 1500 r.p.m. the forward speeds are $2\frac{1}{2}$, $3\frac{1}{2}$, $4\frac{3}{4}$ and $9\frac{3}{4}$ m.p.h. in the four forward gears respectively, and 3 m.p.h. in reverse gear. The hydraulic "lift" is supplied by a four-cylinder pump mounted in the transmission housing, which supplies oil under pressure to a ram cylinder. Brakes on the rear wheels can be operated independently or together, and with the use of the brake on one wheel only the turning circle is 16ft in diameter. The weight of the tractor is about 2500 lb.

As an example of the manœuvrability of the tractor and its implements, we note that the firm has tilled an enclosed area, 27ft long and 20ft broad, with tractor and cultivator without leaving a wheel mark.

FIG. 6—"MAJOR" GRASS MOWER—BAMFORD

BAMFORDS, LTD.

For many years now Bamfords, Ltd., of Uttoxeter, has specialised in the production of grass mowers, and the latest addition to machines of this type is the "Major," which has been designed for working from the power take-off of the Fordson "Major" tractor. The Ford Motor Company, Ltd., it may be stated, is co-operating in the production of the machine, which is illustrated in the engraving, Fig. 6. The mower, it will be noted, is mounted on two swivel wheels equipped with ball bearings and rubber tyres to facilitate turning corners and to assist the turning movement when the machine swings back. The drive to the cutter bar is transmitted from the power take-off shaft of the tractor to a sprocket at the rear of the frame and is passed on to another sprocket on the crankshaft of the mower by a chain drive, which is enclosed in an oil and dust-proof casing. The frame of the mower is of wrought steel and the 5ft cutter bar is of the customary "Bamford" type.

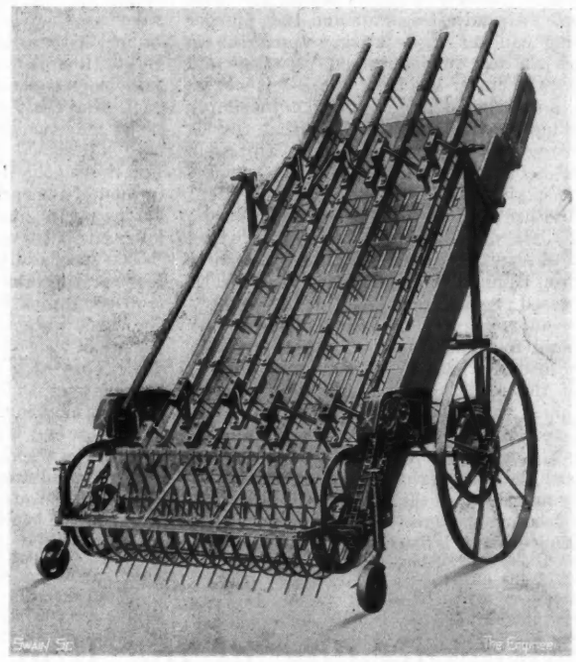


FIG. 7—UNIVERSAL CROP LOADER—BAMFORD

The power shaft is covered for the whole of its length by a sheet iron guard, and is provided with a slipping clutch to prevent breakage should the knife meet with any abnormal resistance. The lifting gear for the cutter bar is operated by a new linkage system, for which a patent is pending. When the cutter bar is raised, the links move through a dead centre position by which means they are self-sustaining without a quadrant. Light leverage is ensured when the cutter bar is raised by a tension spring, and a light touch of the operating lever is said to be enough to break the rule joint lock and return the cutter bar to its working position.

The mower is connected to the tractor by a flat plate, rigidly bolted to the drawbar, the plate incorporating two spaced lugs for a horizontal shaft on which pivots a bracket. The bracket has a vertical pivot, attached to which is a turntable, and to this the drawbar is attached in such a manner that when the turntable rotates on its pivot the mower frame and cutter bar swing with it. The turntable has a cam surface, with a notch at one end and a stop at the other end, and on a laterally projecting portion of the bracket there is mounted a spring plunger carrying a roller. When the mower is in the working position, the roller on the plunger engages the notch on the cam surface and normally the pressure of the plunger spring is sufficient to retain it in that position. If, however, the cutter bar meets with an obstruction, pressure is exerted on the plunger spring and the plunger is forced backwards, dislodging the roller from the notch on the turntable, so that the mower

frame and cutter bar swing backwards until the roller, which during the backward movement travels along the cam surface on the turntable, finally makes contact with the stop. An adjusting nut on the plunger spring can set the releasing apparatus to work at any predetermined pressure, and when the cutter has been released it can be set to its original working position by simply backing the tractor. The roller then travels back over the cam surface of the turntable until it rests in the notch which automatically locks the machine in the working position.

Another exhibit on the stand of Bamfords, Ltd., is a universal crop loader, which has been designed to deal with almost any kind of crop from short green grass to hay. The increased production of silage in this country in recent years has, no doubt, added to the demand for machines of this nature. The crop loader, which is illustrated in Fig. 7, is of the reciprocating crank type, and is equipped with eight rake arms mounted on top and bottom cranks. The cranks have four throws to each revolution, so that a smooth action is given to the machine and jerky movement of the rake arms is obviated. For feeding the crop from the ground, a rotating element is fitted at the bottom of the chute, and consists of a pair of three-armed reels mounted on a shaft. The reels have rake bars so mounted that they are free to rotate on their own axes. On each of these rake bars there is fitted a link, on the free end of which there is a roller, and as the reels rotate the rollers engage in a cam race which positively controls the angular position of each rake shaft throughout the whole cycle of its movements. The contour of the cam race is designed to give a rocking or pendulum movement to the rake bars, so that the motion of the ends of the tines is accelerated as they pass over the ground towards the lower end of the chute.

The speeds of the rotating element or the reciprocating cranks may be varied to suit crop conditions by altering the sizes of the sprocket wheels driving them. Another feature of the rotating element is a stripping device consisting of a number of fixed curved bars between which the tines pass and which prevents clogging.

The rear end of the crop loader is carried by two furrow wheels, the axles being cranked upwardly and fitted into an adjustable sleeve by which, through a screw mechanism, the height of the loader from the ground may be varied.

(*To be continued*)

Modernisation of the Iron and Steel Industry

No. I

IN the following article we begin a review of the modernisation schemes completed and in hand at the chief iron and steelworks in this country. Information on which the article is based was given by the British Iron and Steel Federation.

Consett Iron Company, Ltd.

Modernisation schemes in hand at Consett Iron Works have a total cost of some £3,000,000.

The first stage of the programme involves a large scale reorganisation of the energy balance of the whole works. In an integrated plant such as Consett, this is a considerable undertaking. Two new batteries of coke ovens are being constructed, a second new blast furnace will shortly be blown in and the building of another begun, and a very large new boiler plant and power house is being constructed.

The net result will ultimately be that the only fuel to be brought to the works from outside will be coking coal to the coke ovens and low grade fuel to the boiler plant.

The increased amount of blast furnace gas from the new furnaces will have improved cleaning arrangements and will be used to fire the new coke ovens, the surplus blast furnace gas going into the general energy pool. The coke oven gas thus released will be used to eliminate the gas producers on the open hearth shop and mills, thus saving some 2000/3000 tons per week of coal at present used in this way. The open hearth furnaces are to be fired on coke oven gas and the tar by-product of the coke ovens. All open hearth furnaces are being converted so that they may use gas and liquid fuels in almost any ratio, and four are in fact already so reconstructed.

Of the new boilers, of which there are to be five in all, generating between them half a million pounds of steam per hour at a pressure of 450 lb per square inch, three are to be equipped to burn inferior fuels, such as coke breeze; the other two will take care of the fluctuations in the blast furnace and coke oven gas supply systems by means of retort stokers.

Ore and Coke.—Taking the processes in turn, from the preparation of the raw material onwards, we can begin with ore and coke. The ore preparation plant at Consett was installed in 1943, and can crush and screen up to about 400 tons per hour. The sintering plant, consisting of thirteen stands with 2½ to 3-ton pans, can produce about 3500 tons of sinter per week. All the ore used passes through the preparation plant from which it is conveyed by belt to the furnace bunkers. There are some notable conveyors in the plant, totalling nearly 11,000ft in length, the longest continuous stretch being about 1100ft.

The coke oven plant at present in operation comprises a battery of sixty Wilputte ovens, capable of carbonising 7000 tons of coal per week. These ovens some years ago were well before their time in design and remain a quite efficient plant by modern standards. They were, indeed, the first silica walled ovens to be installed in the United Kingdom. Their capacity is to be supplemented by two batteries of Becker ovens, which will carbonise an additional 8000 tons of coal weekly in a total of fifty-four large ovens, each 14ft by 18in by 42ft 5in, giving a coal capacity of 17¼ tons. This additional capacity involves new storage space; the coal will be taken from the wagon tip to the new crusher and from the crusher to the 3000-ton capacity bunker by belt conveyors. The present 1700-ton capacity bunker is fed from the crusher by a bucket conveyor. The present by-product plant will be sufficient for the new capacity, with the addition of new coolers and improvement to the tar distillation plant.

The new coke oven batteries and bunkers are in process of construction and it is hoped that they will be in operation by the autumn of this year.

Blast Furnace Plant.—The blast furnace plant at present in operation consists of two furnaces, No. 8 and No. 2. The former, at present producing hematite iron, is comparatively small by modern standards, having a 12ft 6in hearth, a height of 75ft and an output of 1800 tons per week for consumption of about 22cwt of coke per ton of iron. This furnace is due for dismantling when the new No. 3 is blown in this summer, to make way for the third modern blast furnace to be installed. No. 2 was blown in during 1943, and is a thoroughly up-to-date plant. It has a hearth diameter of 20ft, a height of 92ft, and an output of 4500 tons per week, using imported ore. Its consumption is 17cwt coke per ton of iron.

This furnace is equipped with a McGee distributor top and fully automatic charging arrangements with a central control panel. The present blast furnace gas wet cleaning plant is being supplemented by Lodge Cottnell electrostatic precipitation plant.

The No. 3 furnace shortly to be blown in is slightly larger than No. 2. It also has a 20ft hearth but has an estimated output of 5000 tons per week. Apart from this they are substantially similar. As soon as the new furnace is operating successfully the old, hand-charged No. 8 furnace will come off, to be dismantled to make way for the third modern furnace, No. 1. The net result, pending the completion of No. 1 furnace in two years or more from now, will be a production of between 9000 tons and 10,000 tons of pig iron per week, in place of the 6000 odd tons now produced.

The hematite is all cast over a pig casting machine, as is about 1500 tons per week of the basic iron. The balance of the present make is absorbed as hot metal in the steel melting shop.

Power Supply.—The increased power requirements of the new blast furnace capacity has led to the reorganisation of the supply arrangements for the whole works. Boilers, generating plant and blowers are being concentrated in one new building in course of construction.

There are to be five separate Clark-Chapman boiler plants, each generating 100,000 lb of steam per hour at 450 lb per square inch. All are to be equipped with gas burners, three having stokers for pulverised low grade fuel, and two having retort stokers. It is expected that this new plant will enable the works to generate power at the rate of 12 lb of steam per kWh, against the 20 lb used at present. Two alternators of 15,000kW are to be installed, and two turbo-blowers with a capacity of 50,000 cubic feet per minute at 25 lb per square inch pressure. Installation of the new boilers is expected to begin early this summer, to be followed (when three boilers are installed) by the turbo-blowers, then by the other two boilers and eventually, in early 1948, by the alternators.

The Consett plant was originally sited where excellent coking coal and easily mined ore were both readily available, and began operations (as the Derwent and Consett Iron Company) as long ago as 1840. The local ore, however, soon gave out, and since then the plant has operated on imported ores. The high grade coking coal is as plentiful as ever, indeed, a useful seam was actually uncovered while the foundations for the new power house were being dug. The present extensions, therefore, are no more than a continuation of the company's obvious policy of profiting to the utmost from the site's natural advantages. An increased iron and steel production offset by every possible economy in fuel is part of Consett's very real contribution to national recovery.

Workington Iron and Steel Company

The Workington Iron and Steel Company has a highly integrated plant. It is probably unique in this country, since within a "ring fence" only a few miles long, there are available all the raw materials for the production of iron and steel, most of them still under the control of the Company.

Developments at these works have been steadily proceeding on a long-term plan since 1932. Since that date no less than £3,250,000 have been spent in modernisation and improvement schemes. It must be remembered that West Cumberland was, during the greater part of this period, a distressed area. The benefits of such expenditure as this, therefore, can be truly assessed only if weight is given not simply to increase in efficiency and economy, but also to the hope and determina-

tion shown and generated in the dark days. Present progress, therefore, in modernisation proposals can best be seen against the background of the fifteen-year plan.

The plans drawn up in 1932 were, of necessity, of a long-term nature. Because the company was probably the largest employer of labour in the County of Cumberland they included projects to widen the scope and quality of the products produced hitherto, so as to broaden the basis of employment. The proposals covered, very broadly, the following four principal aspects :—

(1) Raw material departments, including the production of iron ore, iron ore crushing, screening and sintering plants, limestone quarrying and its ultimate preparation for use in the blast furnaces, and a new coke oven plant.

(2) The concentration, modernisation and rebuilding of the whole of the Derwent blast furnace plant at Workington, together with ancillary plant such as gas-cleaning, pig-casting, slag and iron disposal, &c.

(3) The replacement of the former acid Bessemer steel-making plant by a new plant of larger capacity, and the modernisation of the rolling mills.

(4) Improvement and modernisation of ancillary plants, including services such as steam, electric power, water, supply and general maintenance departments, &c.

Raw Material Departments.—Four major projects were undertaken, which are now very largely completed.

In the prospecting and developing of a new iron ore field south of Egremont, including the sinking and equipping of the Hale Moor Mine care was taken to make the mine as attractive to the employees as possible. The mine is all-electric; no steam is used, and the shaft is elliptical, affording the maximum use of the excavated area. An output of 1000 tons per week has been attained, which was of great service during the later years of the war, when imported supplies of hematite ore were hard to obtain.

In 1937 a new raw materials stockyard was completed. This stockyard, which is served by a 12-ton "Titan" travelling grab, has a capacity of 100,000 tons of ore. From the stockyard the ore proceeds *viâ* a new crushing and screening plant to the blast furnaces, the fines obtained from the screening being diverted to the sintering plant. All material from the stockyard to the blast furnaces is handled by means of a 60-ton electrically-driven transfer car. The capacity of the crushing and screening plant is 300 tons per hour and has only been brought fully into use this year.

The sintering plant consists of a two-pan "Greenawalt" plant and has been in production for some years now; its capacity is 4500 tons of high grade sinter per week. No material larger than 2½in in size is sent to the blast furnaces, so this plant is equipped and operated in accordance with the best modern practice.

In 1932 the company operated four limestone quarries, all of which largely used hand methods of getting. Concentration resulted in the closure of three of these quarries and the operation of the remaining quarry on two shifts per day. During the hours of darkness the quarry was flood-lighted, large capacity cars were introduced, and at the same time the quarry plant was electrified. Diesel electric shovels for loading were also put into operation. Well blasting was also introduced, by means of which tonnages of up to 40,000 tons of limestone were brought down at one operation. The existing crushing and screening plant was partially modernised in 1934, but is now being entirely replaced by a modern large-capacity two-stage crushing and screening plant, which will deliver stone screened and graded to 2½in maximum.

In 1936 a completely new coke oven plant, comprising fifty-three ovens of the "Becker" type, was erected at the Derwent works by the Woodall-Duckham Company. In 1940 an additional eleven ovens were added. The capacity of the combined ovens is 7000 tons of blast furnace coke per week. The erection of these ovens permitted the closure and dismantlement of certain older type ovens at the Harrington and Moresby collieries then owned by the company.

The Derwent coking plant, in addition to supplying coke to the blast furnaces at Workington, is also the nucleus of the West Cumberland gas grid. This gas grid is becoming of greater importance with the erection of new factories in the development area of West Cumberland. The by-products of this coking plant are dealt with at the nearby chemical plant of the United Coke and Chemicals Company, Ltd.

The expenditure during the past fifteen years on the plants mentioned has exceeded £1,000,000.

Blast Furnace Plant.—This plant consists of three large-capacity furnaces, having a combined output of 8600 tons per week.

In 1932 No. 2 blast furnace was replaced by a modern furnace unit complete with skip-loading equipment and all modern mechanical conveniences. The hearth diameter of this furnace is 20ft and it has a normal capacity of not less than 550 tons per day on suitable burdens.

Following the completion of No. 2 furnace, the remaining two blast furnaces were rebuilt on modern lines and provided with common bucket charger and bridge. Electrically-operated mud guns of the Brosius type were also added. At the same time, a replacement programme of the hot blast stoves was undertaken, and to-day each furnace has three hot blast stoves, each of 180,000 square feet heating surface, equipped with Brassert gas-burners and valves.

A new gas-cleaning plant, utilising pre-cooling towers and Thyssen disintegrators, was also provided, and to-day all the gas produced at the blast furnaces is cleaned to very fine limits for use in the blast furnace stoves, re-heating furnaces and boilers.

In 1936 a double strand pig-casting machine was added, and all sand casting ceased. The whole of the blast furnace plant has thus been completely rebuilt and modernised.

The expenditure on this portion of the plant has been £750,000.

Steel-Making Plant.—In 1934 a new Bessemer plant, comprising two 25-ton vessels, with a 400-ton hot metal mixer, was brought into use. New ingot soaking pits were built with a capacity of sixty-four 3-ton ingots. A new ingot casting shop was also erected. The decision to continue the manufacture of acid Bessemer steel was made in view of the suitable nature of such steel for the manufacture of rails. Experience in recent years has shown the wisdom of this decision.

During the war a three-high finishing mill, having 28in centres, was completed and put into use, and to-day a new cogging mill with electric drive and having a capacity of not less than 8000 tons of ingots per week, is nearing completion. During the intervening years the mill buildings have been modernised and largely replaced.

The White Paper on the Iron and Steel Industry submitted to Parliament in May, 1946, proposed the concentration of production of rails at the works of four principal makers, of which Workington is one. In this connection work is now proceeding on the extension and modernisation of the rail-finishing banks, which will incorporate roller straightening and special finishing machines for rail manufacture.

The expenditure on steel-making and rolling plant will exceed £650,000.

Ancillary Plants.—A new steam boiler plant has been erected, each unit of which has a capacity of 100,000 lb of steam per hour at 420 lb pressure. Two additional units are being installed and on their completion not only will no coal be required for the operations of the company, but the surplus heat when converted into electricity will be available for disposal elsewhere.

Steps to modernise the electric generating station of the company have been taken and shortly this plant will have a capacity of 20,000kW, and will be comparable in efficiency with the best modern standards.

During the war the company completed and purchased from the Government an electric steel-making plant at its Moss Bay works, which is now available for the manufacture of all qualities of steel.

A programme to improve the roads and railways throughout the whole of the works was put in hand and has been completed. Similarly, a programme for the replacement of all older type locomotives and steam cranes has been largely implemented.

A 3,000,000 cubic feet capacity coke oven gasholder is under construction, which will prevent waste of coke oven gas at change of shifts and week-ends.

(To be continued)

St. Lawrence Seaway and Power Scheme

INTRODUCTION in the United States Senate of a Bill authorising the construction of a 500,000,000-dollar deep seaway and power project on the St. Lawrence River does not mean that Canada will take immediate action to have similar legislation placed before Parliament. Canadian Government officials have said frequently since 1941, when the projects were first agreed upon, that no legislative action would be taken in Canada until the United States Congress finally authorised the construction measure. On April 24th, last, External Affairs Minister St. Laurent told the House of Commons that the Canadian Government had agreed in principle to a United States proposal that the projects be made self-liquidating through the imposition of tolls on shipping using the route. Canada, he said on that occasion, would not object to the principle of tolls provided they could be arranged in such a way that there would be genuine benefit to transportation in a reduction of charges by the construction of the seaway. Originally, Canada's estimated share of the costs of the projects was set at more than 275,000,000 dollars, including the 132,000,000 dollars spent to build the Welland Canal connecting Lakes Erie and Ontario. The cost to the United States, as originally estimated, amounted to approximately 300,000,000 dollars. Works that Canada would carry out under the proposed seaway projects, which would provide a 2000 mile channel from the Great Lakes to the sea for ocean-going shipping, would include the excavation of a channel 2000ft wide and the removal of eight projecting points of land in Lake St. Francis; excavations, construction of locks and guard gates, side canals and construction of bridges along the Soulanges Canal; dredging a 27ft channel through five miles of Lake St. Louis to Lachine, Quebec; deepening from 14ft to 27ft the ten miles of Lachine Canal from Lachine to Montreal, and the construction of guard gates, lift locks, dams and the necessary highway and railway bridges. The power projects, which would be made self-liquidating through the sale of electricity, would include the development of 2,200,000 h.p. on the international rapids section of the St. Lawrence, roughly between Morrisburg, Ontario, and Cornwall, Ontario. Half of this power would go to Ontario and the other half to the State of New York. Ontario and New York, in return for the power, would each contribute about 90,000,000 dollars toward the cost of the works.

NORTH CHESHIRE GAS SUPPLY.—According to the *Manchester Guardian*, work is about to begin on the first instalment of a scheme costing £3,000,000 to increase gas production in North Cheshire. New gas works are to be built at Denton at a cost of £1,250,000, and it is hoped that they will be completed in four years. This plant is designed to produce 6,000,000 cubic feet of gas and to process 400 tons of coal daily. When completed, it is understood that it will be used in conjunction with the present works at Hyde as the principal source of supply for the North Cheshire and District Gas Company's system of inter-connected mains serving the Denton, Hyde, Dukinfield, Hollingworth, and Broadbottom areas. This new unit will be trebled in capacity as the whole scheme is completed.

Precast Prestressed Concrete Rail Bridge

FOR over a decade the L.M.S. Company has, wherever possible, carried out bridge reconstructions in precast reinforced concrete. The advantages of this practice can be summarised as follows:—

Reduced Maintenance.—The climate of Great Britain is severe on steel. Painting, generally, must be carried out at least every six years; in some cases every two years. In spite of this, corrosion is often heavy and repairs are frequent. Reinforced concrete, properly made, has been found to require little or no attention.

Ease of Manufacture and Erection.—The units are manufactured in the company's own depot under shop conditions, and production can be carried on throughout the year. The units can be easily placed with the minimum delays to traffic as little or no speed restriction is necessary after erection.

Continuous Roadbed.—A ballasted deck with the advantages of continuity of track is easily provided. Ballasted timber decks have a short life in Great Britain, and are now inadmissible on the L.M.S. The greater mass of the concrete units gives a smaller period of vibration and consequently a less lively track over the bridge.

Cost.—In most cases the precast concrete bridge is cheaper in first cost than the steel bridge, and is decidedly cheaper in equivalent first or annual cost. The only serious disadvantage is that precast concrete units generally require a greater constructional depth than steel.

When first introduced the units were designed as slabs, generally one or two slabs per track. These were used for relatively small spans as the crane power available was not powerful enough to handle loads of more than 10 tons. About 1924 the tee beam type, where the deck consists of four or five independent tee beams placed side by side, was introduced, and when cranes of greater capacity became available about 1934, it was possible to renew spans up to 40ft in this way. While this design was economical and very successful the constructional depth required was considerable and the beams could not be used in many cases, as sufficient space was not available.

The use of prestressed precast concrete had been investigated before the outbreak of war, but was not pursued. Some prestressed precast beams were manufactured early in the war for the Ministry of War Transport for emergency use in road bridges and the experience gained suggested a further study of the use of this method for underbridges. This showed that bridges could be reconstructed with prestressed beams with a shallower deck than with the ordinary type of reinforced concrete, the reduction being of the order of 15 per cent. It was therefore decided to reconstruct an underbridge with precast prestressed beams to determine the economy and advantages of this method of design. For various reasons it was not possible to carry out the work until 1946, when the renewal of the timber bridge known as Adam viaduct carrying two Class I tracks on the line between Manchester and Liverpool was undertaken.

Adam viaduct has four openings, each approximately 30ft span. The abutments were masonry and the intermediate supports timber trestles fixed on masonry foundation. The superstructure consisted of timber beams (braced from the trestles and abutments) carrying a timber deck. The timber trestles were replaced by concrete piers constructed on the old foundations and the deck was formed of precast prestressed I section beams. The beams are 32in deep, the top flange has a maximum width of 20½in and the bottom flange is 16in wide. The web is 4in thick at the centre and gradually increases in width towards the ends from about the third point. The small space between the top flanges of the I beams which support each track is grouted and three 1¼in diameter high-tensile rods, stressed by means of nuts at each end, fix these units together so that they act as one under live load. Two beams on each side support the parapet unit. All beams were placed individually and the grouting and transverse stressing were carried out after erection.

The main reinforcement is hard-drawn wire 0·2in diameter, specially improved steel, with a guaranteed breaking strength of 100 tons per square inch (224,000 lb per square inch). Secondary reinforcement and stirrups were of ordinary mild steel. The concrete mix was designed to have a minimum crushing strength on 6in cubes of 6000 lb per square inch in twenty-eight days or 4000 lb per square inch in seven days, using a high early strength cement. There was no difficulty in obtaining this strength, the mix used being approximately 1 : 3½ (30 per cent sand) and the water/cement ratio being approximately 0·45. The concrete was vibrated into position with external vibrators, as internal type vibrators were not available at the time of manufacture.

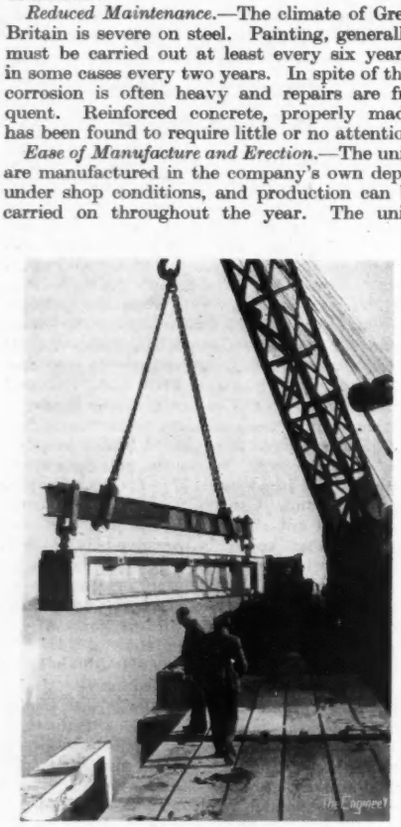
Loading tests were carried out on two of the beams by supporting them at the ends and applying a point load at the centre by means of a jack reacting against a temporary load. This test load was equivalent to the designed load plus 50 per cent, which required the application of a point load of 26¼ tons. The maximum deflection recorded in the case of one beam was ¼in and on the other $\frac{5}{16}$in. In both cases there was no permanent deflection and the beams returned to their original hogged condition after removal of the test load. There was no sign of cracking during the test. All beams were manufactured at the L.M.S. Railway Company's precast concrete depot at Newton Heath and were dispatched from there to the site as required by the erection operations.

The operating department was unable to agree to any track possessions other than at week-ends, and it was ultimately decided that the erection of the bridge should be carried out by removing the existing structure and replacing the piers with military type steel trestles and the deck with the temporary steel girders carried by these trestles. By this method it was possible to construct the new piers during the week without interfering with the traffic over the bridge. When the piers had been completed a portion of the temporary deck was removed and replaced with the new beams during week-end possessions.

The original schedule provided for the placing of the new deck to be carried out in four separate operations, the units in two spans on one road to be dealt with in each operation. The first two operations were carried out as scheduled, but the experience gained indicated that it would be possible to carry out the remaining two operations in one occupation. This was arranged and was easily carried out in the time allowed. Owing to the fact that the only cranes available were of very slow operation, the average time for lifting a beam and placing it in position was about 10 min., but with a fast-acting crane this time could be substantially reduced.

When the units had been put in place, the transverse tie rods were inserted in the holes provided in the top flange and after the grout between the units had taken up, these were stressed by operation of the nuts using a calibrated tension spanner. The ballast was then placed in position, the new track laid and coupled up and the bridge brought back into traffic.

While the units were manufactured in the L.M.S. depot, the actual erection work was carried out by contract, the temporary trestles and deck being provided by the company and installed by the contractor. The design and



PLACING A BEAM IN POSITION

ADAM VIADUCT COMPLETED

construction of the bridge was carried out by the L.M.S. chief engineer's department under Mr. W. K. Wallace, chief engineer. The Pre-Stressed Concrete Company acted as consultants for the design of the prestressed beams. The construction of the new piers and the erection of the beams was carried out by Leonard Fairclough, Ltd., contractors.

L'Ecole Nationale des Ponts et Chaussees de France

On June 20, 1947, the French National School of Bridges and Roads celebrated the bi-centenary of its foundation. This is an important event in the world of civil engineering. A system for training in the arts and sciences which constitutes the education of an engineer, that was established so long ago, is unique, not only by virtue of the Act of Establishment, but also by reason of the clear logical concept on which it was based, and the breadth and vision with which its pioneers construed the training necessary. The school was brought into existence under an Order in Council of State dated February 14, 1747, which provided that Monsieur Perronet, its first director, who was the engineer of the Alençon District, should have the training and inspection of the cartographers and draughtsmen of plans and maps and the instruction of these draughtsmen in the science and practice necessary to enable them adequately to fulfil their varied duties connected with bridges and roads and to be responsible for the maps, plans and relative documents. Before 1747 there had been an interesting development which led up to the actual foundation of the school: in 1738 the Controller-General, Orry, had installed an Administrator of Roads and, later, in 1743, a Steward of Finance, Trudaine, to take charge of bridges and roads. It has to be borne in mind that these works, so far as the main highways were concerned, had for several centuries been the responsibility of the Crown.

It was the desire of Orry that priority should be given to the roads joining Paris to the ports and to the frontiers. Owing to financial difficulties, the work could not be executed quickly enough and he had to resort to the system of statute labour. Trudaine quickly saw that to avoid delay, plans of the routes would have to be drawn to define the zones comprising the parishes which would have to provide statute labour, and to indicate the new lines of the roads concerned. A Central Office of Draughtsmen was established and by January, 1744, three draughtsmen had been enrolled. The number increased to seven in 1745 and to thirteen in 1746.

Trudaine next developed the idea of creating an establishment which would embrace: (1) the Central Office of draughtsmen and cartographers organised in such a way that knowledge in engineering could be acquired by the most capable of them, but so that all the students of the school contributed to the work of preparing plans and drawings; (2) the Registry of plans.

Perronet, to whom was entrusted the task of realising this conception, was thirty-nine years of age at that time, and for the next ten years he devoted all his energy, as well as his technical knowledge, to its realisation.

The administration of the Roads and Bridges Department comprised a first or chief engineer, four inspectors general, and twenty-one engineers, sub-engineers, and sub-inspectors. The effective number in 1775 was about fifty inspectors and eighty sub-inspectors. Perronet raised the standard of scientific and technical knowledge of the students of the school, so that after gaining experience as subordinates, they were fully qualified for the higher posts. The fact that this higher standard was attained is the result of the Order founding the school, in 1747.

The organisation of the school as originally drawn up by Perronet underwent modifications and changes of detail from time to time. Whereas Perronet had accepted some students on the simple test of personal qualities and good general education, at a later stage competitive examinations were introduced. The number of students varied, but generally numbered sixty or more, divided into three classes. An instruction given on December 11, 1747, directed that if in the course of two years a young man employed in the third class had, because of inaptitude or dissipation, not qualified for next class, he was to be discharged as unsuitable. Perronet was not able to create special Chairs under the titles of Professor, as in our day, and the teaching of the sciences, mathematics and design of plans was by an original form of mutual assistance. In this way the school could be run very economically. During this period the subjects included in the curriculum were building construction and design, roads, bridges, hydraulic works, such as sea-walls, jetties, reservoirs, canals, seaports, water supply, &c.

While these subjects were obligatory, the students were encouraged to seek instruction in the studios of distinguished architects engaged upon the principal public works of the time and to take courses in physics, natural history and chemistry. In this way students were able to increase the range of their knowledge. Competitive examinations were instituted, the judges being the Inspectors General of the Department of Roads and Bridges assisted by the Members of the Academy of Science and Architects and Painters, the awards being made the occasion of a formal ceremony. It was an essential part of the system that part of the training should include actual employment, both in the office and upon works, and special directions were given to ensure a balanced training. The merits of the system so created by Perronet can be measured by the results achieved. 15,000 miles of principal roads well aligned and paved were provided on the basis of methods designed by Tresaguet, the engineer to the Province of Limousin, in 1764. Bridge construction was particularly active, Perronet himself building, among others, those at Chateau Thierry, Sainte-Maxence, Neuilly—of which Arthur Young, the English traveller said: "It is the most splendid that I have ever seen."

The most important works at the commercial maritime ports executed by the Roads and Bridges Department were at Dunkirk, Dieppe, Havre, Rouen and La Rochelle. The Department was also responsible for the construction of the military port and sea-wall at Cherbourg, and for many other important works.

During the period from 1804 to 1851 the organisation underwent a number of changes, including the institution of entrance examinations. On entering the school, the students underwent a preparatory course in the first year. In the second year the subjects included architecture, administrative law, electrical technology, general hydraulics and hydraulic machinery, materials of construction, geology, prime movers, bridge construction, public works construction, strength of materials, topography and the practical control of public works. In the third year, reinforced concrete, railways, administrative law, political and financial economy, electricity, applied hydrology and general internal navigation, metal bridges and marine works were studied. Lessons in English and German were also included and there was an oral examination for each course. In addition, the second year students had to work out eight projects and the third year, seven. For two months in each year the student engineer was employed on major constructional works which were in progress.

Throughout varied changes, the school has continued during the course of its long history to render great services to France, due largely to the professors chosen, so far as the technical courses are concerned, from the engineers of the department. These engineers have made important contributions to science and technical advances into theory of elasticity, and have included Navier, Cauchy, Clapeyron, Saint-Venant, Bresse, Maurice Levy and Resal. One of them, Augustin Fresnel, was the inventor of optical equipment for lighthouses and the first to introduce the wave theory of light.

With their colleagues of Belgium, the engineers of the Roads and Bridges Department inspired the creation of the International Roads Congress. They have continued the tradition of fine bridges set up in the eighteenth century by Sejourne, Caquot, Freyssinet. The spirit of Perronet animates them always and they remain faithful to the principles he established.

Manufacture of Textile Plant

In common with all other engineering concerns in this country, the group of companies within the Mellor Bromley organisation were fully engaged on the production of armaments during the war, and, since the cessation of hostilities, have concentrated on a speedy and complete return to normal work. To demonstrate the almost complete reconversion to the production of textile plant, which has now taken place, an interesting tour of inspection of two factories in the Leicester area was recently organised by the company. It was shown that, in addition to the work of conversion, a new factory on a seventeen-acre site has been built, staffed and equipped and is now in full production. The visitors were informed that the work of reorganisation has proved so successful that the total output of the groups is now well in excess of the pre-war figures.

The group of companies within the organisation are as follows: Mellor Bromley and Co., Ltd., manufacturers of knitting machines for every type of garment, of textile accessories and of air conditioning plant; Samuel Pegg and Son, manufacturers of dyeing and finishing machines; Pegson, Ltd., manufacturer of roadmaking, quarrying, agricultural and general contractors plant; Brown and Green, Ltd., manufacturers of laundry equpment; and L. Tansey and Co., Ltd., manufacturers of latch needles and knitting elements.

A brief visit was first made to the new works of Samuel Pegg and Son, in Barkby Road, Leicester, where all types and sizes of dyeing and finishing plant for textiles was seen in course of manufacture. We were informed that many improvements have been made in these plants in the light of recent developments, in materials and processes. In particular evidence were some good examples of fabricated stainless steel sheet work which is used to a large extent in this class of machine.

Visitors were then taken to the main works of Mellor Bromley and Co., Ltd., in St. Saviour's Road, Leicester, where a comprehensive range of knitting machines is made for knitted garments and fabric of every type. Machines are built for knitting all classes of yarns from the most delicate silks to heavy woollens and even wire. Each machine is a complicated assembly of interdependent units working at very high speeds, and successful operation of this type of plant, particularly when working in delicate yarns, naturally depends upon the accuracy and timing of the component parts. Each part is an excellent example of precision engineering design and manufacture, and is made to limits rarely encountered outside a toolroom. A system of batch production has been introduced for making the components, and in the testing department the visitors had evidence of the consistent high standard of workmanship which is maintained. In this department a selection of knitting machines of all sizes and for a variety of yarns were seen in operation prior to delivery.

THE ENGINEER

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ELECTRONIC ENGINEERING

Morgan Brothers (Publishers), Ltd., Proprietors of THE ENGINEER, THE IRONMONGER and THE CHEMIST AND DRUGGIST, announce that they have acquired the monthly periodical ELECTRONIC ENGINEERING (incorporating Electronics, Television and Short-Wave World) from the present owners, Hulton Press, Ltd.

Morgan Brothers (Publishers), Ltd., will be responsible for the publication of ELECTRONIC ENGINEERING commencing with the August issue. All correspondence should, therefore, be addressed to ELECTRONIC ENGINEERING, 28, Essex Street, Strand, London, W.C. 2. The Editor and the Staff will continue to serve the paper under its new proprietorship.

NOTICE TO READERS

All letters intended for insertion in THE ENGINEER, *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

FARM MACHINERY

THE resumption this week at Lincoln of the Royal Agricultural Society's annual show is an event which will impart a feeling of some satisfaction, not only to the farmers, but also to the agricultural engineers of this country. For since its early days the "Royal" has regularly provided an opportunity for an ever-widening range of agricultural machines to be displayed, and has enabled the engineers who design and manufacture those machines to discuss with the farmers who use them their merits, their possible development, and ways in which improvements might be made to existing types. By means such as these and by the machinery trials which have been so successfully carried out in past years under the ægis of the Royal Agricultural Society, valuable progress has been made. Of this year's Show—the first in the post-war period—it can be said that though the machinery exhibits are not quite so numerous as those at the Centenary Show at Windsor in 1939, many thousands of technical and non-technical visitors have been impressed by the variety of farming implements which have proved themselves such a vital factor in this nation's food production. It is true that many of the machines and tools are much the same as those which existed in 1939, but the fact that this year there were no less than sixty-two entries in the Silver Medal competition for new implements is ample evidence, if any is needed, that the agricultural engineer's inventive faculty has not been dormant during the last eight difficult years.

Farmers, it has been said many a time, are inveterate grumblers, and in past days they may have complained about plans for mechanising their industry or criticised the increasing number of implements which they thought perhaps engineers were trying to foist upon them. But those days, we suggest, have gone, and farmers are now as ready to use as engineers are to develop and produce the machines which are necessary if the land is to be tilled and crops harvested quickly and satisfactorily. A glance at the census of farm machinery carried out last year by the Ministry of Agriculture gives a good indication of the rate of progress in the mechanisation of agriculture. Between 1944—the year of peak wartime food production—and 1946 the number of three-wheel and four-wheel tractors in use in this country increased by nearly 20,000, or 14 per cent, while the number of track-laying tractors increased by over 30 per cent. In the same period the number of combine harvesters employed rose by nearly 50 per cent, and tractor mowers by 30 per cent, and there were also substantial increases in the usage of tractor ploughs, potato spinners and milking machines. Facts such as these surely show that the industry of agriculture has come to appreciate the advantages of mechanisation.

As engineers, we certainly do not doubt that appreciation by farmers of the possibilities of machinery will continue to grow. At the moment the agricultural engineer, like all other engineers, can only do his very best, in the face of the many current shortages, to provide the farmer with the right tools for the job. To overcome the delay in this year's farming operations caused by the extreme severity of the weather in the winter and early spring imposed a further heavy strain upon all available sources of agricultural machinery, while the harvest that is now imminent calls for as much reaping, threshing and root-handling machinery as can be mustered. It is some measure of satisfaction to know that, despite the importance of our export trade, the Board of Trade is co-operating with the Ministry of Agriculture and is permitting manufacturers to direct a larger quantity of farm machinery into the home market. But with the continuing shortages of raw materials and particularly of steel, agricultural engineers are finding it increasingly difficult to maintain the output of implements. It is a measure of the changed and changing attitude of farmers to farm machinery that, despite the weight of criticism often directed against the design of such machinery, the demand for it so far exceeds supply.

ALL-WING AIRCRAFT

THE Royal Aeronautical Society's Wilbur Wright Lecture was this year delivered by the well-known American engineer, Mr. J. K. Northrop, president of the aircraft construction firm which bears his name. His subject was the development of all-wing aircraft, the field of work in which he is recognised as one of the leading pioneers. This choice of man and subject was timely, for a number of factors have lately combined to cause engineers to realise that the flying-wing form of aircraft design may have some marked advantages. No one would expect it to show improvements over the more familiar designs in every respect, and there is without doubt a debit as well as a credit side to the account. What is needed, therefore, is a careful and frank assessment of both sides of the balance sheet in order that the nature and weight of the overall advantage or disadvantage may be realised.

It must be admitted that to strike such a balance cannot be easy, for apart from obvious differences in purpose of military and civil types of design, there is the overriding difficulty of making a weighted comparison of the human and technical factors. It is plain, for instance, that even in existing types of airliner one would have far stiffer, stronger and lighter structures if all openings in the body for windows and emergency doors could be omitted; that would certainly be an advantage from the technical point of view, though from the purely human one it certainly would not. In this extreme case it is not hard to see where the overall advantage lies. But in some cases it is not so simple. Thus, in a large flying-wing airliner, the passengers instead of being seated in a long coach-like body, with a row of windows on each side out of which they can get some view of the outside world, might find themselves confined in a span-shaped space of great aerodynamic efficiency but with little facility for the provision of any external view and with no great amount of headroom. Can they be expected to like that? How far would such craft be popular with the air-minded public? With the air-freighter type it would be another matter, but even there one has to face the practical question whether it is not in fact much handier to load and unload goods in and out of the ordinary kind of ship-shaped fuselage than it is ever likely to be from the interior of a wing having a variable depth and chord length. If the all-wing design would seem here to be at some disadvantage, there are undeniable aerodynamic and structural advantages which must equally be taken into account. On the structural side it is easy to see that since it is the air forces acting along the wing that carry the load, it would make for structural lightness if the freight could be equally evenly distributed along the wing, since in that way the bending moments on the main spars would be lessened. A real merit in the design is seen in the reduction in the "wetted surface" exposed to

air drag through the absence of the fuselage and tail units. Hence, for a given load and engine power, the speed should be higher, or if designed for the same speed, the range for a given fuel capacity would be longer. An increase in speed would, moreover, make the craft better suited for the use of turbo-jet engines, in which case the absence of any tail would ease the choice of position for the hot jets. A need for control organs somewhere, to replace those which would otherwise have been located in a tail, would still exist; and their natural place would be at the tips of swept-back wings, though, as the leverage is then less than a tail design would provide, the forces are greater, with a risk of wing flexure and twist enough to alter the local air forces, and so make the pilot's control harder and the provision of inherent stability less easy. In military types very high speeds may be insisted upon, and if a flying regime is approached in which shock-waves develop from some part of the wings, there is gain in having no tail organs operating in air so disturbed. Very high speeds will be the more readily obtained if the suction-operated Griffith type of wing now under test should succeed. Whether this wing could equally work with pressure rather than suction and whether, if it did, the outflowing jet would provide a material proportion of the engine thrust is one of the unknowns. There are indeed an immense number of factors on which we are still ignorant, but it is encouraging to learn from Mr. Northrop that in his judgment the elements are sufficiently favourable to justify his firm in constructing a very large all-wing aircraft, so large indeed as to call for eight jet engines, each with a thrust of 4000 lb. This craft it is hoped will make its first flight this year and its performance will be watched with great interest.

At the close of the lecture the new President of the Royal Aeronautical Society, Dr. Roxbee-Cox, remarked that whilst some engineers preferred a maximum of body with a minimum of wing, and others a maximum of wing and a minimum of body, to aim for the flying-wing was to be "on the side of the angels." If many will sympathise with this high aspiration, there will be some, including not a few air passengers, who will hope that it may not happen too soon.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE PUBLIC WORKS, ROADS AND TRANSPORT EXHIBITION

SIR,—When the Public Works, Roads and Transport Exhibition opens at Olympia on July 21st, many friends among the visitors will be disappointed to find that our members are not represented. In explanation, it should be stated that when it was learned in October of last year that the exhibition was to be held in July, 1947, the exhibition authorities were informed that our members would probably not be able to participate owing to the difficulties of existing abnormal manufacturing conditions, together with the additional difficulties arising from the exhibition being held in the holiday season and the Building Trades Exhibition having been fixed for November of this year.

This was subsequently confirmed, with regret, in accordance with the unanimous decision of our fifty-one members.

THE FEDERATION OF MANUFACTURERS OF CONTRACTORS' PLANT,
BINDER, HAMLYN AND CO.,
Secretaries.

London, E.C.2, June 24th.

HUMAN RELATIONSHIP IN INDUSTRY

SIR,—May I presume upon your valuable space to point out what is, in my opinion, a very dangerous fallacy in the classification of human relationships, as set out by Mr. Rice and Mr. Gillespie in your issue of June 20th? I have no quarrel with the first three divisions, namely, the "O," the "I–It," and the "I-You" relationships. It is with the "We" relationship about which I am not at all confident.

This No. 4 relationship is described as "community friendship, in which the self is subordinated to the common good." I would much prefer to leave out the relative clause, which vitiates the whole category. The common good is an abstraction which to mean anything in terms of behaviour must be concreted around behaviour. The difficulty arises that what is or is not proper behaviour is relative to personal opinion and given circumstances. It follows that the common good may be interpreted differently by different people at different times. On the other hand, because it is a general phrase, everyone may agree that there is such a thing if we knew how to find it. If these factors are taken into conjunction with the attraction of grouping to most personalities, one possesses the key to the creation of totalitarian ruthlessness. That phenomenon is a direct result of removing from the individual the responsibility for his own actions, and substituting for that responsibility "the common good," which means exactly what a clever dictator may want it to mean. The group can be, and as we know often is, far more ruthless than any individual.

The "We" relationship, as defined in the article to which I refer, leads straight to the "I–It" relationship. Any society which is prepared to ask its individual members to subordinate themselves to the common good becomes a powder magazine of canalised and compressed emotion. I would like to suggest that the fourth category of human relationships is the same as the "I–You" relationship, but containing the phrase "bargaining modified by an act of faith." To put the matter bluntly, there is no room for religion in any of the categories established in your article except in the "I–You" relationship.

In so far as the scientific approach is debarred from comprehending man's capacity for religious belief, it is not an appropriate instrument for the study of human relationships. In so far as human relationships base themselves upon pseudo-scientific terms, such as "the common good," human relationships must deteriorate into collective antagonisms. Community friendship is only healthy when it expresses a complexity of individual friendships.

HOPETOUN.

London, W.C.2, June 26th.

Lloyd's Register of Shipping Technical Committee

ON Thursday, June 26th, we received from Lloyd's Register of Shipping particulars of the membership of its reconstituted Technical Committee. The constitution of the Committee has been widened in order to provide for representation from the following bodies which have not hitherto been represented:—Shipbuilding Conference, National Association of Marine Engine Builders, Dry Dock Owners' and Repairers' Central Council, British Iron and Steel Federation, National Forgemasters' Association, Institution of Electrical Engineers, and British Electrical and Allied Manufacturers' Association. The interest of the technical institutions has been retained. At the inaugural meeting of the Committee on Thursday, June 12th, Sir Frederick Rebbeck was elected Chairman and Mr. P. B. Johnson and Mr. Charles Connell Vice-Chairmen. The Committee appointed a panel of shipbuilders and naval architects to co-operate with the chief ship surveyor in the revision of Rules for Steel Ships. The following is a list of the Technical Committee with the names of the members and the nominating body:—Institution of Naval Architects, Mr. H. B. Robin Rowell and Dr. S. Livingston Smith; North-East Coast Institution of Engineers and Shipbuilders, Mr. F. W. Dugdale and Mr. P. B. Johnson; Institution of Engineers and Shipbuilders in Scotland, Sir Stephen J. Pigott and Mr. S. B. Ralston; the Shipbuilding Conference, Sir Wilfred Ayre, Mr. Charles Connell, Mr. J. Ramsay Gebbie, Mr. F. O. John, and Mr. Henry Main; National Association of Marine Engine Builders, Mr. Harry Hunter, Mr. Harold E. Sheardown and Mr. Ewen H. Smith; Institute of Marine Engineers, Mr. H. S. Humphreys; Society of Consulting Marine Engineers and Surveyors, Sir Harold Fortescue Flannery, Bart.; Dry Dock Owners' and Repairers' Central Council, Mr. G. S. Cromar and Mr. James Patton; Iron and Steel Institute, Mr. A. MacLeod; National Forgemasters' Association, Sir Arthur Matthews; Honourable Company of Master Mariners, Captain F. G. Spriddell; Institution of Electrical Engineers, Mr. H. Dewar Wright; British Electrical and Allied Manufacturers' Association, Mr. C. Wallace Saunders. Nominated by Lloyd's Register General Committee: Shipowners, Mr. H. Barraclough, Mr. L. O'B. Harding, Sir W. Guy Ropner, and Mr. W. L. Denholm; underwriters, Mr. H. G. Chester, Mr. H. W. Edmunds, and Mr. Harold H. Mummery; shipbuilders and engineers, Sir Frederick Rebbeck, Sir Summers Hunter, Commander Sir Robert Micklem and Sir Llewellyn Soulsby. Nominated by the Technical Committee: Shipbuilders, Mr. W. T. Butterwick and Mr. J. S. Redshaw; engineer, Mr. J. Gilchrist; superintendents, Mr. J. Gray and Mr. J. Baird. In addition there are the following nominations by branch committees of Lloyd's Register abroad:—One by the American, Swedish, Holland and Danish committees. The Chairman, Deputy Chairman and Chairman of Sub-Committees of Classification of Lloyd's Register are also *ex-officio* members of the Technical Committee.

Literature

Building and Structural Tables. By F. H. Blake, B.Sc., M. Inst. C.E. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 21s. net.—This book of tables has been compiled to present in convenient form the data most frequently required in the design and construction of buildings. The information has been grouped by subjects, and the general system of arrangement keeps to the same order as the designer normally follows in computing his loads, commencing with the roof and following through to the foundations. Architects, builders and constructional engineers will find this a useful little book for quick reference purposes.

The Installation and Maintenance of Air Compressors. By D. Braid, A.M.I. Mech. E. London: Emmott and Co., Ltd., 21, Bedford Street, W.C.2. Price 2s. 6d. net.—In his preface the author points out that many air compressors are installed without sufficient attention having been paid to details which would give the best service and the minimum plant maintenance changes. For this reason a series of notes dealing with all aspects of air compressor installation, from the choice of a suitable site and erection to starting up and running in, have been prepared, and are presented in a concise, comprehensive manner in this useful little book. It is not intended as a treatise on air compressors but as a practical guide to potential users on their installation.

The Incorporated Municipal Electrical Association

THE impending nationalisation of the electricity supply industry may well mean that the 1947 Convention of the Incorporated Municipal Electrical Association, which was held in Bournemouth during the week of June 23rd to 27th was the last annual gathering of the Association as at present constituted. For the future of the Association remains to be determined at a special meeting to be called after the Minister of Fuel and Power has given notice of the vesting date when the industry will be transferred to national ownership. Undoubtedly there is a strong feeling that the Association should be continued in some new form, but future action depends very largely on the extent to which, under the new proposals, the local authorities are given some form of local control. Their claim to something more effective than a consultative *rôle* is being diligently pressed, but hitherto without much success, as was stated by Mr. J. S. Pickles in his Presidential Address.

On Tuesday morning, June 24th, the first session of the Convention opened with a civic reception by the Mayor of Bournemouth, Councillor J. W. Moore, J.P. In a short address of welcome the Mayor, speaking of the Association, expressed the hope that a new organisation would be built on the foundations of the old, since it was now necessary, more than ever before, that all trades, professions and industries should have an organisation that could speak collectively for them.

There followed the Presidential Address by Mr. J. S. Pickles, the electrical engineer to the Dumfries County Council. Mr. Pickles spoke briefly of current events, load shedding, the fuel crisis, nuclear energy, hydro-electric developments and rural electrification, before passing on to nationalisation of the electricity supply industry—the main theme of his Address, abstracts from which were published in THE ENGINEER of June 27th on page 566.

Power Station Practice

Tuesday afternoon, June 24th, was devoted to the discussion of a paper on "Recent Developments in Power Station Practice," by Mr. F. W. Lawton, chief engineer and manager of the Birmingham electricity supply department. This paper contained a comprehensive review of the progress made in power station practice since Mr. Lamb and Mr. Baumann presented their paper on this subject before the Association in 1938. The main developments since then have been concerned with higher steam conditions, higher turbine speeds, boiler availability and higher generation and transmission voltages. Rising coal prices are rapidly bringing higher steam conditions into the economic range, and increased plant prices have concentrated attention on larger generating units running at higher speeds. The growth of æsthetic consciousness has caused increased attention to be directed to power station architecture. The search for additional sites for power stations has revealed the increasing necessity for cooling towers, and the problems of ash disposal and grit emission associated with pulverised fuel firing have caused alternative methods to be considered.

It is with these subjects that the paper is mainly concerned, and the author's conclusions are summarised below.

The most important developments in power station practice during the last decade have been associated with higher steam conditions, accelerated by rising fuel prices. Due to the deterioration of fuel quality and to the large proportion of obsolete plant in commission, the average overall power station efficiency has in this country remained practically constant for about ten years. The highest yearly station load factor has reached 88.28 per cent and the lowest number of men employed for operation and maintenance 1.3 per 1000kW of maximum demand.

The chain grate stoker appears at present to be limited to an evaporative capacity of 250,000 lb per hour, with optimum steam conditions of 900 deg. Fah. and 900 lb pressure, and the cult of the retort stoker is declining. Pulverised fuel firing is on the increase for large boiler units and the spreader stoker—a newcomer in this country—is invading the realm of existing firing methods.

Boiler sizes in this country do not exceed 500,000 lb evaporative capacity, whilst in America boilers of 1,000,000 lb capacity have been built. In this country the draining type superheater is gaining in popularity, as is the standardisation of terminal conditions for boilers and turbo-alternators.

Feed-water conditioning is of growing importance as higher steam conditions are used, and alloy steels become necessary in superheater tubes and steam pipes. The arrangement of steam piping has become a major consideration as a result of higher steam conditions, as has the design of the low-pressure turbine blading and thermal expansion of turbine rotor and cylinders has to be guarded against.

It has been shown that cooling tower and condenser design are intimately connected, and that the economic vacuum is of the order of 28.5 Hg, also that cooling towers of 100,000kW are likely in the near future on economic grounds.

Controversy concerning the generation of auxiliary electrical supplies and the several methods of obtaining variable speeds for fans and pumps still prevails and local considerations must be relied upon for a decision.

Direct generation at 33kV has proved satisfactory, and there is an increasing tendency to step up from a lower generation voltage to 132kV for transmission over greater distances. Hydrogen cooling of alternators is economically justified at an average yearly load factor exceeding 40 per cent for machines in excess of 50MW capacity, and is a contribution to fire precautions.

Air break auxiliary switchgear up to 3300V and 150MVA breaking capacity is a recent development which is yet another contribution to fire precautions, as is air blast switchgear for voltages above 33kV. Between these limits the oil-immersed gear holds the field on economic grounds.

Fire precautions depend much on station lay-out and plant design, and save for segregation there are few general principles capable of universal adoption.

District heating associated with the main power station heat cycle is not generally favoured. A separate plant having heating as its main function and generating electricity as a by-product is generally more satisfactory.

With larger and more standardised machine sizes, station lay-outs are becoming more uniform, and power station architecture is becoming more individualistic and less prone to imitate contemporary or mediæval architecture.

Gas turbines are not likely appreciably to exceed the efficiency of modern steam turbines operating with the higher steam conditions, and the increased cost of operation of the gas turbine is offset by the reduced capital charges, hence the use of gas turbine is likely to be confined to peak load working.

Atomic energy for electrical generation is still in the experimental stage, and until other elements more abundant and cheaper than uranium are found to be successful for this purpose, the present methods of electrical generation are likely to prevail.

Wednesday, June 25th, provided an opportunity to relax from the official business of the Convention, for the day was given up, according to custom, to excursions and visits. Many delegates, however, took the opportunity of visiting the electrical exhibition at the Majestic House Garage.

Legislation

On the following day a paper on "The Law Relating to Electricity Supply," was presented by Mr. R. Birt, borough electrical engineer and manager, Ealing. Mr. Birt's paper was divided into two parts. The first part dealt with the history and development of legislation, whilst the second part dealt with the alteration in the law resulting from the provisions of the Electricity Bill, 1947. Naturally the second part of this paper was confined to an outline of the original proposals, although Mr. Birt attempted to indicate the present position at the report stage of the Bill. Two matters stood out in the discussion of this paper. First there was a general demand for clarification and codification of the legislative position when the Bill becomes an Act. Secondly, Lord Citrine, Chairman of the Organising Committee, addressed the meeting. Speaking of the I.M.E.A., Lord Citrine said that he had no desire to uproot organisations that were performing, and were still capable of performing work that was beneficial to the industry. In general, the aim was to take all that was good in the industry at the moment and develop it to its fullest extent, the final aim being the provision of the high service to which the public was entitled.

Professor J. D. Cockcroft was the guest of honour at the Convention banquet on Thursday evening. Proposing the toast of "The Association," Professor Cockcroft outlined the prospects for the commercial use of nuclear energy.

Fuel Utilisation

There was a tendency, said Professor Cockcroft, to expect that our fuel difficulties might soon be solved by the newest and most spectacular discovery of science—nuclear energy. It was true that, by splitting the atom, we had opened up the prospect of a new source of heat and power. It was true also that from the burning of 1 ton of the lighter form of uranium in a nuclear furnace we could obtain the same energy as from 3,000,000 tons of coal. It must be remembered, however, that electrical science and technology had taken more than fifty years to develop from Faraday's discovery of electromagnetism to the first electricity undertaking.

Although the rate of development had increased enormously since Faraday's time, we must not expect miracles in the rate of development now. We should rather ask what was the present state of our knowledge, what were the technical problems to be solved before full utilisation of nuclear energy could be made, and, finally, what would be the capital cost of changing over to nuclear energy and how could such a programme be integrated with our expanding needs for power.

The general conclusion was that, whilst nuclear power had great potentialities and was worth a determined effort, its relative importance in the next ten to twenty years was far from certain. We should not therefore be distracted by its rather dazzling promise from a search for economy in our present standard fuels. There was considerable room for improvement, Professor Cockcroft suggested, in the overall efficiency of thermal utilisation of coal, in the thermal insulation of buildings and in the field of space heating. These were positive ways of improving our position in the next two decades, during which any progress from nuclear energy could be regarded as an acceptable bonus.

Mr. J. Eccles, President-Elect of the I.M.E.A., proposed the toast of "The Guests," and Mr. V. Z. de Ferranti, President of the Institution of Electrical Engineers, responded.

The Convention concluded with the annual general meeting on Friday, June 27th. The report of Council for the year ended May 31, 1947, was adopted without discussion. It dealt with the various activities during the year including the Electricity Supply Bill.

A resolution calling on the Council to consider the future of the Association was also welcomed by the Council, the President remark-

ing that the matter had already received consideration by the Council and that counsel's opinion had been taken on certain points. A point brought out in this opinion was that the Council could not pay compensation to officers and staff for loss of office, but it was understood that an amendment to the Electricity Bill giving such powers would be accepted by the Government and would be inserted in the Bill. Finally, the President said that in due course a special meeting of the Association would be called to decide what should be done in the future.

A further resolution which received the strong support of certain smaller authorities and was carried, although there were some dissentients, asked that steps should be taken to secure the insertion in the Electricity Bill of a clause providing that compensation should be paid for any losses sustained by an electricity undertaking where these exceeded the amount that had been paid to the relief of local rates.

Mr. J. Eccles, city electrical engineer, Liverpool, was elected President for the coming year and Councillor J. Selwyn-Jones, Newton-le-Willows, Vice-President.

Two Jig Boring Machines

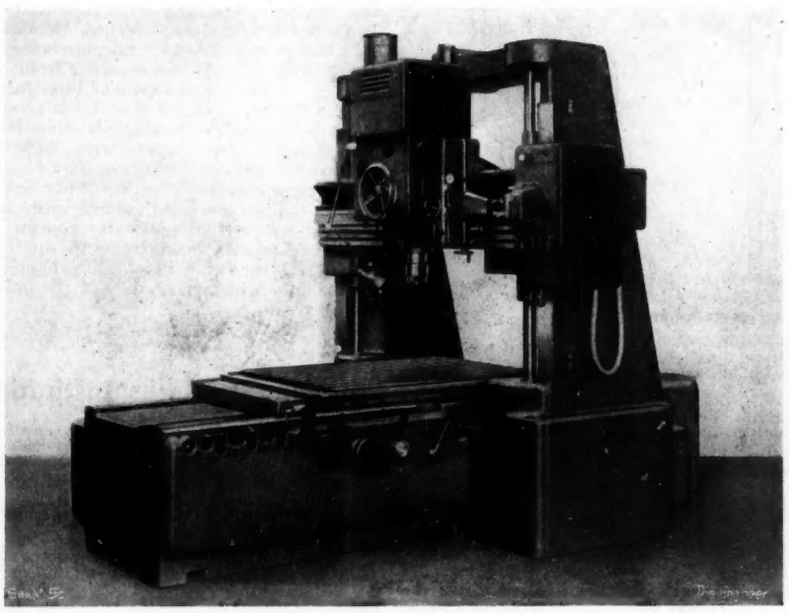
IN the course of a recent visit to the works of Société Genevoise in Geneva, we had an opportunity to inspect two new jig boring machines, which have been added to the range of precision machine tools made by this well-known company. We found that these machines are used extensively in the maker's own shops, and it was interesting to note how their rigid design and construction, combined with their versatility and ease of operation, suited them equally well to both high-precision production and the finest class of tool and jig making.

The larger of the two machines was the "Hydroptic No. 7" jig boring and milling machine, which is illustrated below. It is of particularly large capacity, having a distance of 63in between the uprights and a maximum height of a little under 38in between the table surface and the spindle nose, whilst its table is 61in long by 40in wide. A number of the new features which have been incorporated in this machine will not only serve to reduce the idle time, but also the degree of physical effort normally imposed upon an operator when setting and working such a large machine to the highest degree of accuracy and output of which it is capable. Quick and easy means of control are of particular importance in operating a machine of this type and size, and for this reason the makers have provided groups of interconnected push-button controls in easily accessible positions on each side of the table and on the side of the cross beam. The incorporation of hydraulic feed to the work table and rapid power traversing means to the cross beam speed up and assist in operation and supplement the inherent working accuracy of the machine.

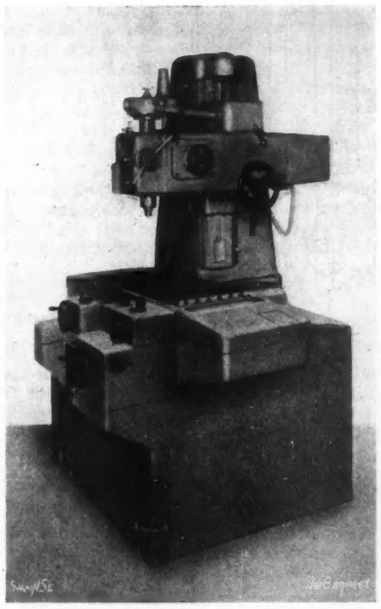
Components up to nearly 2 tons in weight can be accommodated on the work table which is designed to traverse longitudinally along the bed for a distance of 55in. In order to give consistently smooth travel and in view of the heavy loads it is designed to take, the table is fitted with guide rollers to reduce friction and wear on the bed and the ways. When the machine is being used for milling, the table can be traversed under hydraulic power at infinitely variable feed speeds up to 12in per minute, and a rapid power traversing can be effected at speeds from 80in to 100in per minute. An extremely fine inching traverse operated by push buttons on the quill housing, is provided to facilitate accurate table positioning when the work set on it is being checked. The hydraulic power traverse is effective over 52in of the table movement and for setting purposes an additional 4in of travel available is set by means of a hand wheel. This hand wheel gives a table movement of 0·005in per revolution and is used in conjunction with the makers' well-known "Hydroptic" measuring system when setting the machine. With this system the table and spindle head are first set to 0·1in with reference to external scales, and then by reference to micrometer drums and verniers to 0·001in and 0·0001in respectively, the readings being made on large-diameter drums and in microscopes.

The cross rail or beam supporting the spindle housing is moved on the ways of the two rigid uprights by means of screws which are operated by an electric drive. As the combined weight of the beam and the spindle saddle is in the region of 2 tons means have been introduced fully to relieve the weight on the screws before the power for movement comes into effect when raising or lowering the cross beam. In this way the screw threads are not subjected to any wear, and the initial accuracy of their alignment is maintained. Movement of the cross beam is effected through a directional control lever on the side of the control panel. When this lever is raised, hydraulic clamps which hold the beam to the columns are released as oil under pressure is admitted to hydraulic cylinders built into the cross beam. Then oil is introduced into two vertical hydraulic cylinders at the front of each column to thrust the cross beam off the control flanks of the elevating screws. When the cylinders have taken the weight off the screws, a reversible electric motor driving the screws is automatically switched on and they begin to rotate. As the cross rail moves the supply of oil to the hydraulic cylinders is maintained, and the rate of feed is so arranged that the screws are relieved of the weight of the rail throughout its movement. When the control lever is released, the motor is switched off and the vertical support cylinders are open to drain. Thereupon the beam levels on to the control faces of the elevating screws and the clamps are automatically applied and locked. If the control lever is depressed to effect the lowering of the cross beam, the same sequence of operations is followed, so that in either direction the weight is first taken from the screws by the hydraulic cylinders before they are power driven.

The spindle saddle, which has a movement of 40in on the cross beam, is set by optical means. In order to reduce wear, a counterbalancing device is incorporated to relieve the upper way of a majority of the weight of the saddle during movement. The arrangement of the counterbalancing mechanism can be seen in the drawing reproduced overleaf. For counterbalancing purposes the weight mechanism which serves to balance the quill is used to transfer the bulk of the load on the main upper way of the cross beam to an auxiliary rail set at the rear of the way. The chain carrying the weight passes over two sprockets, one in the saddle and the other adjustably supported from a link plate A at the end of an arm B projecting rearwards from the top of the saddle. A lever C connects the link plate with the carriage of a roller D, which runs on the auxiliary support rail. This lever C is pivoted at E. It will be appreciated that when the saddle-locking clamps are released there is a



JIG BORING AND DRILLING MACHINE

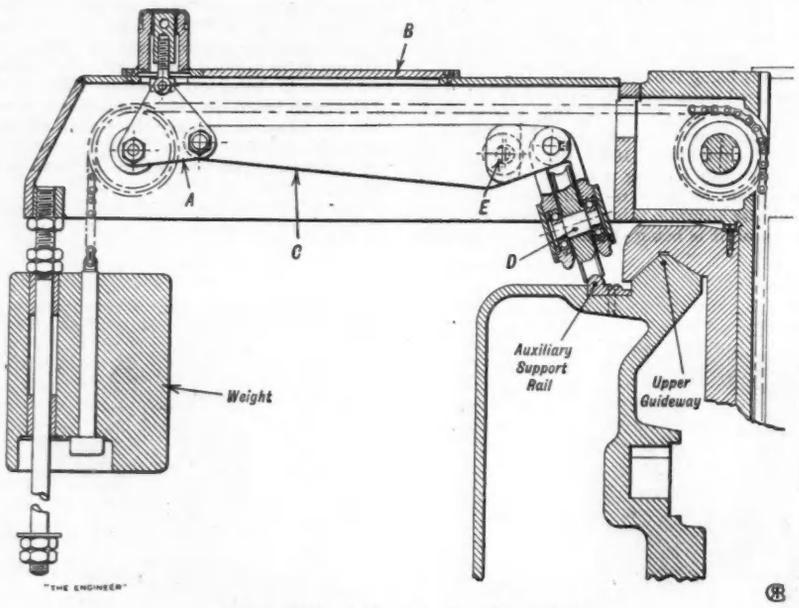


SMALL JIG BORING MACHINE

tendency for the link plate to tip counter-clockwise by virtue of the tension imposed on the chain by its weight. This tipping movement is counteracted by the pivoted lever C, which transfers the load imposed to the auxiliary rail and relieves a large proportion of the weight which would otherwise fall on the main upper guideway.

In order that it may be used for milling purposes the saddle is designed with power feeds of 1in, 2in, 3in and 6in per minute, and incorporates means of rapid power traverse at a rate of 60in per minute. For fine setting for locating purposes a hand wheel, which moves the saddle 0·025in per revolution, is provided.

The spindle has a vertical movement of 12in and under rapid power can be traversed at a rate of 0·79in per second. For spindle setting purposes there are two hand wheels, one of which gives a vertical movement of 7in per revolution and the other 0·15in per revolution. Eighteen spindle speeds, from 40 to 2000 r.p.m., are available, and for setting and checking purposes slow speeds of 4, 5 and 6 r.p.m. can



SADDLE COUNTERBALANCING MECHANISM

readily be brought into service by means of push-button control. Eight power feeds from 0·0005in to 0·012in per revolution are available in both directions of spindle movement. A spindle depth-measuring device on the saddle covers its full length of movement and has a dial indicator calibrated to 0·0005in.

A non-stick taper in the spindle permits easy locking and removal of tools. The tool shanks are made with pairs of lugs by which they are loosely held in the spindle nose to prevent their being accidentally dropped prior to locking, and when they have been released.

The capacity of the machine for heavy work will be appreciated from the maker's claim that holes up to 2¾in can be drilled from the solid in cast iron at the maximum spindle power feed of 0·012in per revolution. Holes 10in diameter can be bored with a cut of ⅝in and a feed of 0·004in per revolution. When used for milling purposes it is stated that a cut 0·2in deep and 2¾in wide can be taken with a table feed of 12in per minute.

No description of this interesting machine would be complete without a brief reference to some of its push-button operated automatic control features. As has already been mentioned, most of these push-button controls are duplicated on each side of the table, and on the cross beam. Spindle speeds are indicated on a large index dial and changes, which are effected by operation of two push buttons, can be made whilst the spindle is running. One of the push buttons operates gear-changing mechanism, which, as the speed ratio increases, moves the index finger round the dial in a clockwise direction. The other button operates the mechanism on reverse and the index moves back in an anti-clockwise direction as the speed ratio decreases. When either button is depressed the spindle motor stops and a brake is applied to stop rotation. As long as pressure is maintained on a button the speed-increasing or reducing mechanism continues to operate. When the required speed is indicated on the dial the button is released, and the spindle automatically starts at that speed. If at any time during normal running a slow spindle speed is required for checking purposes, depression of a push button automatically stops the spindle from anything up to its maximum of 2000 r.p.m., and restarts it at 6 r.p.m. or less. Upon use of the restart button the spindle is restored automatically to its original speed. Spindle feeds are also set by means of push-button control and the rates can be varied during actual running if required. In this case the feed stops momentarily and then restarts at the new rate.

When a big job is being set on the table with reference to the spindle, the operator can use push-button controls in the saddle either to inch or slowly traverse the table, without necessity for his getting down to operate the normal control levers. The normal illumination of the microscopes and scales used for setting can be intensified at will by depression of a button.

The smaller of the two machines, known as the 2H, is also illustrated. Its table, which has a working surface 12½in wide and 27½in long, has a longitudinal travel of 16in and a traverse movement of 10in. The ways of the table cross slides are specially designed to give low and uniform friction, whilst an effective method of protecting them from dust and coolant ensures a long and consistently accurate working life. Table setting is effected by optical means, and each slide can be locked firmly after adjustment without affecting the initial setting.

The slide which carries the boring spindle, the gearbox and the motor is moved vertically on the rigid column at the rear of the machine through rack and pinion gear. A weight suspended inside the column serves to counterbalance both the slide and the spindle separately by means of a differential lever, which distributes the load of the two bodies.

The spindle runs in self-adjusting high-precision ball bearings, and has a travel of 5in. It has eight speeds from 200 to 3000 r.p.m., and two power feeds of 0·0008in and 0·0023in per revolution.

In order that the temperature variation which takes place in the slide whilst the machine is running shall not affect the initial accuracy of the spindle, the boring head is mounted in a separate housing at the end of the slide. This housing is effectively insulated from the main casting on which it is rigidly supported by four Invar bars.

The spindle is bored to take tools of No .1 Morse taper and has an external taper of ample dimensions, in which can be mounted the locating microscope and certain of the boring tool holders. A depth-measuring device is provided, and works in conjunction with an indicator dial reading to 0·0005in. An adjustable support is incorporated in the depth-measuring gear to permit the use of slip gauges.

Building Apprenticeship and Training Council

It is announced that Sir Malcolm Trustram Eve, the Chairman of the Building Apprenticeship and Training Council since its inception in 1943, has tendered his resignation to the Minister of Works, who has accepted it with great regret. The Minister has appointed Sir George Cater as Chairman of the Council. Mr. E. F. M. Durbin, the Parliamentary Secretary to the Ministry of Works, in thanking Sir Malcolm on behalf of the Minister, the Ministry and members of the Council for the great work he had done, said he had made everyone "apprenticeship conscious." In his reply, Sir Malcolm briefly touched upon the four years' work of the Council. In 1943 the first report laid down the minimum standards for apprenticeship and certificates of completion of apprenticeship were issued. The second report set up the Welfare Fund which to-day had shown its first fruits in the offer of four scholarships. In the not too far distant future, Sir Malcolm said, there should be ten to fifteen scholarships, apart from other monies received from other sources. Higher education had been fostered by the Council. At the start there were 300 students receiving pre-apprenticeship education, and the latest figures were 7300. The third report dealt with the training of men for higher supervisory and management posts and student apprenticeships, along with senior building courses and university courses. Sir Malcolm expressed the hope that the apprentice training scheme would, in some form or another, continue as a permanent part of the building industry.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

DIMENSIONS OF UNSCREENED MAGNETOS

No. 5027. This British Standard is a revision of the Standard for the dimensions of unscreened magnetos, which was last revised in 1924, when it formed one of a series of specifications dealing with automobile materials and parts. It deals with the dimensions of base-mounted and spigot-mounted unscreened magnetos, of the E, G, K and M types, having particular reference to those dimensions which affect the interchange of magnetos, but it does not cover magnetos for use in aircraft. It sets out overall dimensions and fixing dimensions, sizes of tapers and keyways, and defines the position of the keyways on armature spindles. Tolerances applicable to those dimensions which affect interchangeability are included, and particulars of the gauges for use in connection with tapers are given in Appendices. Price 3s. 6d., post free.

IMPACT TEST FOR CAST IRON

No. 1349 : 1947. The test covered by this specification has been developed as a result of research work undertaken during the war years to determine the shock resistance of grey cast iron. The specification lays down the dimensions of the test piece which has been found most satisfactory for cast iron, and gives details of the modifications to the grips in the 120 foot-pounds pendulum type machine which is used for the test. Details of the testing point to be checked on the machine before the test is carried out and the testing procedure are also included.

All-Weather Airport Approach Lighting System

A NEW all-weather approach lighting system which has been developed by the Westinghouse Electric Corporation, Cleveland, Ohio, is claimed to be visible through 1000ft of the thickest weather, when objects 50ft away cannot be seen in daytime. The system includes flash units, the brightest lighting units ever made, that will give up to 3300 million peak beam candle-power for use in "zero-zero" daytime, and blaze units that are controllable so they can be set to emit a soft red glow of about 100 candle-power for use on clear, moonless nights. Between these two extremes are steps of candle-power suitable for intermediate weather conditions.

Preliminary tests at Cleveland municipal airport are said to have shown that the transition from instrument approach to visual landing can be accomplished easily under any condition of fog. Advantages of the system are claimed to be the big range of candle-power which permits approaches to be made during any kind of weather, day or night, and that the system requires no additional equipment on the aeroplane. It works equally well with any type of instrument approach system, such as the instrument landing system (I.L.S.), ground controlled approach (G.C.A.), or Microwave, and is said to be the first system of lights with enough power to be of use in foggy daytime, with characteristics that cannot be mistaken for any other type of light.

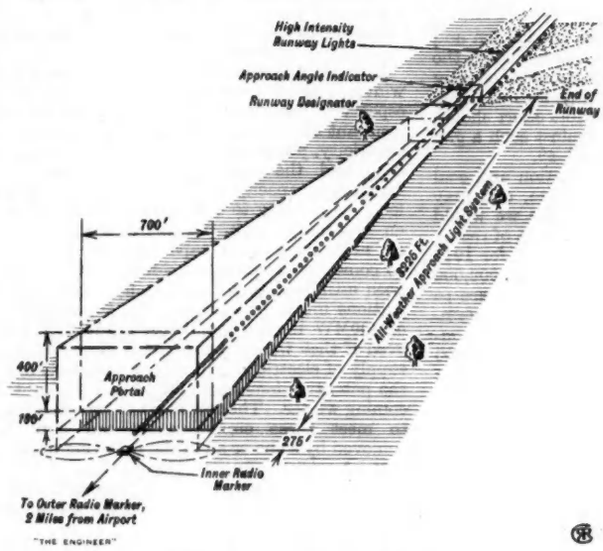


DIAGRAM OF APPROACH PATH

The complete system consists of three parts—the approach line, the runway designators and the high-intensity and runway lights.

Approach Line

The approach line is a single line, parallel to and 25ft to the left of the extended centre line of the runway, as shown in the accompanying diagram. These lights are the pilot's first visual contact with the ground as he leaves instruments while passing through the approach portal. In heavy weather when the lights are operated at the higher intensities, they are flashed successively one after another to give the effect of a streak of lightning travelling toward the end of the runway. A central instrument controls the actions, so that the outermost unit flashes first and each successive unit toward the runway flashes just before the light from the preceding unit appears to be extinguished, thus greatly increasing the visibility of the system, as the eye perceives relatively lower apparent candle-power if positively guided to it.

Flash and blaze units are spaced alternately in the line, 25ft apart for the outer 900ft, 50ft apart for the middle 1000ft, and 75ft apart for the inner 1200ft, with the last unit 150ft from the threshold. The line extends 3225ft out from the threshold to within 275ft from the middle marker of the instrument landing system. All units are aimed at the centre of the approach zone at a point 6000ft from the threshold and at 1000ft elevation. The beam spread of each unit encompasses the normal approach portal.

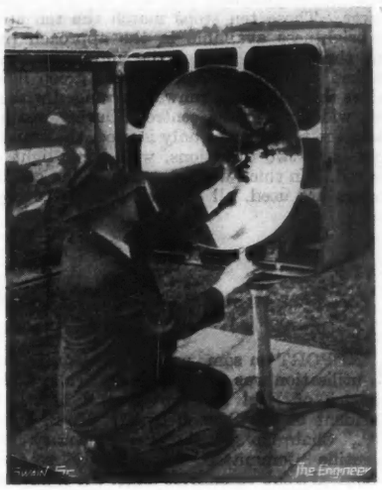
The flash units, illustrated herewith, are extremely high-powered lights used for flashing service only during daytime weather of half-mile, or less visibility and night weather of 500ft or less visibility. They are operated at calculated peak brightnesses of about 1 million beam candle-power on "low" or about 3300 million candle-power on "high." An entirely new type of lamp is used, filled with krypton. The lamp itself produces a maximum brilliance of 9 million candle-power per square inch, which is concentrated by the reflector and optical system to an equivalent of 3300 million candle-power. An idea of its power can be obtained from its energy consumption, which is at the rate of over 3,000,000W during the peak flash period. The light source is a little smaller in diameter than a lead pencil and only about 2in long. The use of heavy walled fused quartz tubing is required; other materials would melt or burst under the heavy discharge at the peak of the flash.

The blaze units are used almost continuously on the approach line day and night, operating as steadily burning lights during weather ranging from clear to hazy daytime and from clear to light fog at night. In thicker weather they operate as flashing lights, complementing the flash units. On steady burning service they produce either 100, 1000 or 10,000 candle-power, as selected, and on flashing service they operate at about 100,000 or 10 million candle-power, as needed. Six lamps are used in each blaze unit. Each lamp, shown in the third engraving, is about 2ft long and as big around as a fountain pen, and is similar to a neon tube except that it has special electrodes and gas filling to permit operation at different brightness levels.

The approach line is a pale red line of 100 candle-power units on clear nights, a bright red line of 1000 candle-power units on clear days and hazy nights, or a brilliant red line of 10,000 candle-power units during hazy days and light fog at night. Then the line appears as a lightning stroke of 100,000, 1 million, 10 million, or 3300 million candle-power, as needed for increasingly worse weather.

Runway Designator

The second part of the system, the runway designator, consists of an assembly of luminous tube elements forming either a green arrow or a red cross. The green arrow indicates that the runway is clear for landing, while the flashing red cross shows that it is closed. During good weather, designators at each end of each runway are used as traffic control aids to relieve the load on radio communications between the control tower and incoming aeroplanes. The designator is a large green arrow pointed toward the runway that is clear for landing. At all other ends of runways the designator is a large flashing red cross, showing it is closed for landings. As an aircraft passes over the green arrow the control officer changes the arrow to a flashing red cross, closing the runway until the aeroplane has landed and cleared the runway. It is then changed back to the arrow, instructing the next aircraft in the landing sequence pattern to proceed.



APPROACH LINE FLASH UNIT

During instrument weather the designator is a last-moment safety signal to approaching aircraft. The green arrow is assurance to the pilot that the runway is clear and that he is at the proper position to make a landing. If an emergency arises that makes the runway unsafe for a landing, the flashing red cross is a warning to pull up and resume position in the traffic pattern until the emergency is cleared.

High-Intensity Threshold and Runway Lights

The third part of the system consists of high-intensity threshold and runway lights spaced at 200ft intervals, 10ft out from both sides of the runway borders, which produce candle-powers up to 100,000. This is 100 times the candle-power of the semi-flush runway lights in common use and nearly three times that of the high-intensity runway light used by the U.S. Armed Forces. The new high-intensity runway light uses three lamps and can be

APPROACH LINE BLAZE UNIT

operated as a high-intensity or a low-intensity unit. For high-intensity service two sealed-beam lamps are used, one for each operating direction on the runway. These lamps, only one of which is used at any time, are operated at 100,000, 30,000, 10,000, 3000 or 1000 candle-power. For low-intensity service the high-intensity lamp is turned off and a single lamp, mounted in a two-directional optical system at the top of the unit, is used. Like the larger lamp, it has five steps of intensity and can be operated to give 500, 150, 50, 15 or 5 candle-power. These ten steps match the ten steps of brightness available in the approach line. The threshold or start of the runway paving is marked by a line of six or eight green lights across the end of the runway, arranged with an 80ft wide gap in the centre. During weather when the top element only is used, the emitted light is in two directions, with some light all around. In thick weather when higher candle-powers are used, all emitted light is severely restricted to the direction of approach. This prohibits background lighting and prevents lighted haze or fog curtains behind each light, which would reduce perception of the next light in the line.

Approach Angle Indicators

As a training means to aid pilots in becoming accustomed to making all approaches and landings as near to the correct instrument approach path as possible, a fourth type of light is used. Mounted in pairs, one on each side of the runway, about 600ft in from the threshold, approach angle indicators project tri-coloured sandwiches of light toward the pilot, appearing as yellow caution lights if he is too high, red warning lights if he is too low, or green lights if he is within safe limits. To avoid confusion with other coloured lights, the indicator signals are pulsed, on for one second and off for one half-second. They are said to be effective in weather down to 1-mile visibility.

Coal Utilisation

A REPORT on some urgent problems of coal utilisation was submitted last Friday to the Minister of Fuel and Power and the Lord President of the Council by Mr. M. P. Price, M.P., Chairman of the Parliamentary and Scientific Committee. This body recently appointed a sub-committee under the chairmanship of Mr. Raymond Blackburn, M.P., to prepare a report on the scientific aspects of coal utilisation. The sub-committee has such a report in preparation, but in view of the urgent problems confronting the country with regard to coal during the next twelve months or so, it was decided to issue forthwith an interim report setting out some recommendations and views with regard to immediate issues.

We print below an abstract of the report.

Interim Report on Coal Utilisation

It is said that if the 1947 production of coal in this country falls to 190,000,000 tons we shall be faced with disaster, whilst 220,000,000 would give us ample for our immediate needs, apart from exports. Such estimates, however, all assume that nothing can be done about the more efficient utilisation of coal. In 1913 only 15 per cent of the potential energy in coal was turned to useful account. Even to-day, nearly 70 per cent of our output is still to all intents and purposes wasted, and not much more than 30 per cent is turned to useful account. Thus whereas on our present utilisation efficiency we can just "pull through" with an output of 200,000,000 tons, if we could increase this 30 per cent efficiency by, say, one-tenth, namely from 30 to 33 per cent, we would have an output equivalent to 220,000,000, which would be ample for our immediate needs, excluding exports. It is therefore essential that just as much effort should be concentrated on the utilisation side of the coal problem as on the production side, and we are convinced that there is still much to be done in this particular field.

To achieve any major improvement in the efficient utilisation of coal by the better application of science is, however, a long-term matter, and one with which we propose to deal in our final report. For the moment, we feel it might be helpful to submit some interim recommendations about the immediate problem of how we are to get through the next eighteen months with the minimum of dislocation of industry and inconvenience to the public.

An important lesson is to be drawn from the extraordinary disparity between the amount of fuel saved during the crisis of 1946–47 and the amount of consequential damage to British industry. The total saving of coal during the whole of the crisis was not more than 2,000,000 tons. Yet it is estimated that the country lost some £200,000,000 of exports as a result. The Chancellor of the Exchequer has warned us that partly on this account the country will have to undergo severe import cuts. It seems evident that even a small gap between production and consumption of fuel at a critical period of the winter has been partially responsible for causing that further lowering of our standard of living which lies ahead. Every possible effort should therefore be made to insure against such a gap occurring in the winter of 1947–48.

Estimates of both coal production and coal consumption are only approximate, and may prove substantially inaccurate, but we would make a tentative estimate in the light of recent production figures that output of coal for 1947 is likely to be not much in excess of 195,000,000 tons. If we have a normal winter and are to approach the export targets which the Government has set us, we should expect the consumption of coal to be not less than 210,000,000 tons. Allowing for perhaps 2,000,000 tons of coal imported, we may therefore be faced with a potential gap of 13,000,000 tons.

Industrial Coal Allocations

Reference to the Statistical Digest shows that productive industry, as distinct from home life, transport and agriculture, directly and indirectly, uses over 100,000,000 tons of coal a year. This includes the consumption by gas-works, coke ovens and electricity generating stations to the extent that these supply industrial requirements. The efficiency with which these 100,000,000 tons are used varies enormously, both as between products and also within one and the same industry producing substantially the same product. One of the first things which requires to be done is to establish and make public for general guidance an efficiency index for every industry for which it is possible. We understand that data for such an index are available in the Ministry of Fuel and Power so far as the greater part of British industry is concerned. It has already been proved by more than twenty-five years' experience in the electrical industry that the publication of figures showing the coal consumed in the generating of electricity is a most potent factor in securing increased efficiency.

In our present crisis the value of such information takes many forms.

It provides the right basis for selecting the industries in which the maximum effort should be made to secure efficiency; it shows where priorities should be directed for the installation of new plant; and if it becomes unavoidable to close down certain works in an industry because the industry as a whole cannot be allocated more than a certain quota of fuel, it provides one of the bases for selecting the firms to be concentrated. The two principles which should govern the industrial allocation of coal in time of shortage are that each industry should receive an allocation of coal in accordance with a system of priorities worked out in the national interest, and that fuel efficiency should be encouraged and that some reward should be obtained by those firms which practise fuel efficiency better than others.

We believe that the following principles should be accepted by the Government and that the Cripps basis of allocation to firms should be modified accordingly.

There should be one Minister responsible for administering the scheme as a whole, and he should be responsible on the advice of the Fuel Efficiency Committee for the issue of directives as to the basis upon which allocations should be made. Allocations to individual firms now based on 1946 consumption should be revised so that the basis should be the amount of coal which would have been consumed by the factory if it had attained that degree of fuel efficiency which would reasonably be expected of it by the best use of its existing equipment. In those industries in which it is possible so to do, a fuel efficiency index should be prepared and used. Allocations to firms should be agreed with the firms where possible, but in default of agreement there should be a right of reference to a regional board containing representatives of the trade associations concerned and of the trade unions. There should be an independent chairman, who would probably be a technical expert. The Fuel Efficiency Committee should be recognised as the body responsible for advising the Minister in the administration of the scheme as a whole.

Consumption of Electricity and the Peak Load Problem

The two major causes of the fuel crisis of the winter 1946–47 were the shortage of coal, especially for domestic purposes; and the resultant enormously increased consumption of electricity, particularly at certain periods of the day, and the inadequacy of the electrical generating capacity of the country to meet the load. According to a statement in Parliament on February 20th, no more than 600MW of new generating capacity are expected to come into commission during 1947. It has been estimated that the capacity of the power stations might be increased by some 300MW or 400MW if they get better grade fuel, but, even if that were supplied, it is clear that the supply of electricity will still be unable to meet the potential demand at all periods during the coming winter. The reduction of the peak load to meet these circumstances can only be achieved by some or all of the following means:

Much more effective organisation of shift systems and staggered hours in factories. Clear Government directions and better incentives are needed in this respect.

Effective action to curtail the peak period consumption of electricity by domestic and commercial (*i.e.*, shop and office) consumers, who are now responsible for about 40 per cent of the load.

Some informal or voluntary rationing scheme for the sale of new electric fires.

Arrangements should be made without delay to provide more domestic consumers with means of heating their homes other than by electric fires during exceptionally cold spells. For example, the mass production and larger sale of some form of cheap and simple oil heater should be encouraged by better priorities.

More effective publicity for fuel economy. Although the official fuel-saving period began on May 1st and closes on September 30th, insufficient energy is being shown in the campaign to persuade the public to economise in the use of coal and electricity, thus building up their own stocks and allowing the power stations to build up reserves.

Improvident domestic use of coal must be discouraged.

Many consumers last winter were prevented from using solid fuel to save electricity by the lack of spare parts, such as grates and flue pipes to enable solid fuel appliances to be used. Immediate priority should be given to the manufacture, distribution and fixing of such spare parts.

Every effort should be made during the summer months to build up emergency coal dumps in all parts of the country which could be used during critical cold spells. These should be as near as possible to the final point of consumption.

Possibilities of Further Oil Conversion

Whilst at first sight it may seem deplorable to import oil fuel from abroad to eke out our

native supplies of coal, we have to remember that a shortage in coal supplies during the past winter of a few million tons lost us exports to the value of £200,000,000. It is therefore well worth while spending generously on the importation of oil, if only to insure against such another disaster.

As a short-term project, the poss bility of converting more of the boilers in our power stations to oil firing should be further investigated. Power stations in this country are already insufficient to fulfil our requirements, and not one must be allowed to close down for want of coal in the coming winter. If for some reason they should be faced with a temporary shortage of coal, it would be a great advantage if they could turn over temporarily, in part, to the use of oil. It is also essential that the maximum encouragement should be given to all who have or can get diesel generators, to use them to the maximum extent possible to assist the electric supply position.

We also believe that a material additional overall fuel economy could be effected under the present plan, if a number of conversion schemes which do not enable fuel oil to show up to the best advantage relative to coal were cancelled as soon as possible and replaced by others in which oil can effect a greater economy. Some conversions were permitted at a time when we were more concerned with the urgent need of saving coal than with the desirability of combining such saving with the advantageous and economic use of oil fuel. There are various industries—steel, ceramics, &c.—where, even if there is an abundant and cheap supply of coal, oil fuel can, in part of the process at least, be used to great advantage. Over an increasingly wide industrial field, liquid fuel is an intrinsic part of the newest and most efficient industrial technique.

It has been estimated that, quite apart from the amount required for the primary purpose of preventing an industrial crisis due to coal shortage, at least 8–9 million tons of oil fuel could be imported with permanent economic advantage to replace coal, even if our coal supplies were abundant. Even this figure of 8–9 million tons, however, does not include the use of oil for diesel-electric locomotives (the advantages of which are already proved), or for use in gas turbines (in the development of which British scientists and engineers have led and should continue to lead the world). In the light of these figures it seems to us improvident to wait until the autumn to reconsider the further development of coal-oil conversion schemes in this country.

Increase of Electrical Generating Capacity

The Government has given the highest priority possible for the supply of manpower and materials for the building of new power stations in this country, but there are other factors besides materials which delay building. So important to the maintenance of our standard of living is the increase of the electrical generating capacity of this country that the possibilities for delaying construction should be severely curtailed during the present emergency. We are informed that 2½ years elapsed before final consent was given for the new power station at Bromborough, that two years and ten months was necessary to obtain consent for the station at Rye House, Hoddesdon, and three years six months for the station at Meaford, Stoke. When the latter station comes into operation, over nine years will have elapsed since the preliminary steps were taken. Again, we understand that permission has been refused for the new power station on the upper reaches of the River Usk, which was to supply the vitally needed increased electrical power supplies of South Wales. It may be true that no station envisaged in the Central Electricity Power's programme up to 1950–51 is being "unduly" held up, but the whole procedure from beginning to end seems cumbrous, having regard to the existing emergency. We appreciate action in this matter could bring no relief during the next winter, but we refer to the question in this interim report because we feel immediate action is called for.

Coal Preparation

The deterioration in coal quality during and since the war has seriously detracted from its efficient conversion into heat and power. The ash in coal supplied to-day is nearly 50 per cent higher than the quantity considered excessive by the pioneers of coal cleaning twenty years ago. The ability of the electricity generating industry to operate efficiently would be substantially increased if coal supplies were better prepared. But even if everything possible is now being done to utilise our existing washeries to the best advantage, a considerable saving of coal would still be effected by ensuring consistency in the supplies of generating stations.

Whilst we recognise that the question of improving the preparation of raw coal raised from our pits still requires extensive study, we are convinced that valuable results could be obtained forthwith if there were to be an immediate tightening up of the operational control of existing washeries and a speeding up of the construction of new and reconstruction of existing cleaning plant. We welcome the assurance by the National Coal Board that they are giving the highest priority to the reconditioning and multiplication of cleaning installations, and we regard it as essential that the requirements of the Board in this connection should be given the fullest effective support by the Government.

We further recommend that immediate steps should be taken to test on a works scale the potentialities of the principal coal components, *i.e.*, the use of coal dust in pulverised fuel furnaces, the use of the caking component in gas retorts and coke ovens, and the use of the non-caking component for boiler firing. Application of the results of research is a necessary preliminary to any plan for efficient coal preparation and cannot be undertaken too soon.

Staggering Hours of Work

A conference was held on June 4th, 1947, between the Confederation of Shipbuilding and Engineering Unions and the Engineering Employers' Federation, at which no definite progress was made. A subsequent informal discussion took place between the parties, with the Chief Conciliation Officer of the Ministry of Labour and National Service in the Chair, at a meeting on Monday, June 30th, as a result of which the following agreement was reached. It will be observed that the agreement does not state the date when the arrangements set out shall come into operation. Such date will require to be determined with the Regional Board, but it is not anticipated that the arrangements will come into operation before October of this year.

Agreement

During the coming winter the capacity for producing electricity during the peak periods of the day will be considerably less than the demand. It is essential, however, that total production of goods should be maintained or increased. In order to prevent cuts or shedding of load, it will be necessary to make arrangements to transfer some of the electrical load from the high peak periods to other periods in which there is surplus electrical capacity available.

The periods during which the electricity supply is not fully utilised are, in general, from 7 p.m. to 7 a.m., during the week, and on Saturdays and Sundays. In addition, certain periods of the day are not so heavily loaded as others and require to be taken into account in providing arrangements which will give the greatest flexibility in arranging working hours, *e.g.*, by staggering hours between groups of works.

The arrangements regarding hours will require to be determined locally in consultation with both sides of industry to meet the varying local conditions regarding power supply, power consumption, &c., but the following general terms and conditions for the engineering industry have been agreed at national level, so that Regional Boards will be in a position to consider the detailed problems in their own areas and go ahead with plans for the coming winter. It is essential that there should be "equality of sacrifice" between firms, districts and industries, according to their various circumstances, and it is on this assumption that this memorandum, relating to the engineering industry, has been drawn up.

In order to maintain production vital to the country's need it is considered a fundamental principle that any arrangements made should provide for a working week not less than the normal one in the industry. There should be a margin available for overtime working beyond the normal hours in a day as may be found necessary to meet production demands.

It is therefore mutually agreed as follows :—

(1) The terms and conditions agreed herein are designed specially to meet the abnormal conditions which have arisen due to the fuel and electricity emergency. They are not intended as a permanent measure and may be subject to review at national level at the request of either party should there be an appreciable change in the conditions which have necessitated this agreement.

(2) Steps to spread the electrical load may be taken by the adoption of certain alternatives or a combination of alternatives. It will be clearly necessary to introduce and to extend nightshifts especially in the case of heavy power users. Where the normal week of the industry cannot be achieved in five days it may be necessary to work Saturday morning. It may be necessary to segregate factories on a local or area basis into various groups working staggered hours, so that the full industrial load will not occur during the dangerous peak periods. Flexibility to meet local conditions is considered essential.

(3) To provide the necessary flexibility, the following working conditions will apply :—

Nightshift.—(*a*) Hours worked on nightshift shall be paid under existing nightshift conditions, as provided in the National agreement.

Saturday morning.—(*b*) It is agreed that Saturday mornings may be worked for the purpose of making up the full normal working week ; such hours between 7 a.m. and 12.30 p.m. shall be treated as normal hours and be paid at normal time rates.

Dayshifts (Monday to Friday, inclusive).—(*c*) Provided the hours worked per day do not exceed the new range of normal hours which in total will give a forty-four hour week (including Saturday morning, if this is included in the arrangement), hours worked between 7 a.m. and 8 p.m. shall be treated as normal hours and paid at normal time rate.

(*d*) Hours worked before 7 a.m. and after 8 p.m. shall be paid under the terms of the National Overtime Agreement.

(4) *Overtime.*—Overtime shall be paid for hours worked before or after the new starting and stopping times, arranged to meet the electricity position, in accordance with the principles laid down in the National Overtime Agreement, *i.e.*, each recognised normal day stands by itself.

(5) In localities where continuous shift working is in operation and where week-end working may be required to spread the electrical load, special arrangements regarding terms and conditions for week-end work shall be arranged locally between the parties concerned.

(6) Any questions arising under this Agreement shall be dealt with in accordance with the normal Procedure for Avoiding Disputes.

Glass Data Sheets.—Technical information in loose leaf form about glass is being issued by the research department of Chance Brothers, Ltd. The purpose of these publications is to enable customers and other interested parties to build up a useful reference manual on the technology of glass and the best methods of working it. The data sheets are to be issued in five main groups : physical properties ; chemical properties ; optical properties ; working and processing and manufactured glass articles.

Industrial and Labour Notes

Factories in the Development Areas

The Distribution of Industry Act, which was designed to bring employment to the Development Areas, has now been in operation for two years, and early this week the Board of Trade issued a progress report on the factory construction work that is being undertaken. The work has involved the acquisition of land, the conversion of Royal Ordnance factories, the allocation of surplus Government factories, negotiations with 2000 industrialists, and the placing of a considerable number of building and civil engineering contracts.

The report states that, under the heading Government financed building, work is proceeding on 120 sites, totalling 2297 acres. which are situated in the North East, Wales, West Cumberland, Scottish and South Lancashire Development Areas. Civil engineering contracts placed amount to over £2,000,000, and negotiations for the purchase of forty further sites, totalling 551 acres, are in hand. With regard to the actual construction of new factories, the report says that sixty factories, with a total area of 1,583,000 square feet, have been completed for tenants who are in occupation. When in full production, they will provide employment for over 10,000, and though most of the manufacturers have only just started production, employment has already reached about 4000. A further forty-one factories, with a total area of 1,532,000 square feet, are nearing completion and when in full production will employ another 10,000 people. Of the remaining factories under construction, ninety-seven are at the steel and brickwork stage ; steelwork is being erected at thirty-three ; foundations are in hand at eighty-five, and site work is proceeding for forty-nine. In all, therefore, 365 factories, with a total area of 13,417,000 square feet, and capable when in full production of employing 90,000 people, have been started since the Distribution of Industry Act was passed. Some information is also given about the conversion of ordnance and other wartime factories. There are now thirty-four firms occupying these factories and 17,800 people were being employed in them at March 31st.

In addition to the activities of the Industrial Estate companies, the report indicates that fifty-four Government-owned factories in the development areas have been allocated to private firms. The potential employment in these is estimated at 36,000, the current employment being 16,300. Furthermore, approval has been given to 445 privately financed schemes of factory construction, the potential employment figure in this section being 70,300. Of these schemes, eighty-six have been completed, 195 are under construction, and on 164 building has not yet started. Summarising the progress of plans for increasing employment in the Development Areas, the report says that the total potential employment figure is 348,400, current employment being 90,700.

Factory Building and Extensions

A recent question in Parliament asked how many factories in the South Wales Development Area were unable to begin production because of steel shortages, and what steps were being taken to improve supplies. In reply, the Parliamentary Secretary to the Board of Trade stated that the occupation of two factories in South Wales was being delayed owing to the shortage of steel, and several firms had withdrawn applications for new factory space because steel supplies were inadequate. In determining the distribution of steel supplies, full regard was had to the desirability of overcoming as quickly as possible shortages which delayed the starting up of production in factories in the development areas. The Parliamentary Secretary regretted, however, that the present steel supply difficulties would preclude any immediate improvement in the situation.

The T.U.C. and Winter Electricity Plans

The general council of the Trades Union Congress considered, at its monthly meeting on Wednesday of last week, the difficulties likely to arise from an inadequate electricity supply for industry during next winter unless action is taken within industry to meet them. Reports made to the council indicated that the situation brought about by new factories coming into production, the extension of existing factories, and the failure so far to arrange for an adequate range of staggering of working hours might be even more serious than that which prevailed during last winter, unless proper steps were taken immediately.

The extent of unemployment and under-employment which would result from cuts in electricity supply, and the subsequent detrimental effect on the production drive, led the general council to the conclusion that it was necessary to ensure that staggering of working hours and the transfer of some part of the load to night shifts in order to relieve the peak load period for electricity. The council decided, therefore, to ask the Minister of Labour to convene a special meeting of the National Joint Advisory Council at the earliest possible date to give this urgent problem full consideration.

The T.U.C. general council also had before it a report regarding the formation of Joint Production Committees which the National Joint Advisory Council has submitted to the Minister of Labour. It was decided to ask that the Minister of Labour should, through his joint consultative committee, draw up and circulate model rules and constitution for Factory Production Committees with a view to their adaptation to the requirements of various industries. The question of linking these production committees with the machinery of the Regional Boards for Industry is understood to be receiving consideration.

The International Labour Conference

A conference convened by the International Labour Organisation opened at Geneva last week, and was addressed on Thursday by the Minister of Labour, Mr. George Isaacs, who referred, amongst other matters, to Britain's shortage of manpower. He told the conference that the labour shortage in this country was being relieved in some measure by the employment of European workers, explaining that they were being paid the same wages and served under exactly the same conditions as British workers.

Mr. Isaacs then went on to say that the shortage of manpower could only be made up by improving productivity, and assured the conference that everyone in this country was becoming increasingly alive to that fact. A method that was being adopted for stimulating production was by encouraging, in agreement with both sides of industry, the formation of joint committees in industrial establishments.

Later in his speech, Mr. Isaacs urged that the collaboration of all Governments, employers and workers was essential if a successful solution was to be found for the world's economic ills. The United Kingdom, he asserted, believed implicitly in the virtues of industrial self-government, and its system of industrial relations rested firmly on the machinery of collective bargaining between employers and trade unions.

Mr. Isaacs added that the British Government's intention was that exactly the same principles of collective bargaining should apply in nationalised as in privately-owned industry, and mentioned that in 1945 the number of workpeople in this country covered by joint voluntary agreements was 12,250,000, compared with 10,000,000 in 1939.

Scotland's Coal Production

As part of his campaign to stimulate coal production and to obtain first-hand information regarding the problems and difficulties to be overcome, the Minister of Fuel and Power, Mr. Shinwell, visited Edinburgh on Friday last for discussions with the Scottish Divisional Coal Board and the Scottish Area Executive of the National Union of Mineworkers. According to the Ministry of Fuel and Power, Scotland's contribution to the United Kingdom's coal target requires an output of about 480,000 tons a week and, although Scotland has not done badly, that figure has not yet been reached.

The Ministry points out that there are special reasons why it has been more difficult to attain in the five-day week the level of production previously reached. In the first place the average length of the working week in Scotland was already greater than in other coalfields, the average number of shifts possible per face-worker each week being about half a shift more than the average for Great Britain as a whole. Further, absenteeism in Scotland at the coal face was lower than in any other region and this has continued since the five-day week came into effect, so that in this respect there has been much less room for improvement than in other areas. Average daily output, however, has risen by about 14 per cent, which has been secured to a substantial degree by higher output per man-shift at the coal face. At the same time, the gains secured have not been enough completely to offset the loss of output through the shortening of the working week.

The Ministry observes that some disturbing features have emerged in recent weeks. The marked improvement in attendance in May was not fully maintained in June, and while May was remarkably free from disputes at collieries in Scotland, the amount of output lost through this cause in June increased sharply.

On the other hand, juvenile recruitment to the coal-mining industry has been better in Scotland than elsewhere, although housing difficulties in the region tend to hamper recruitment in general. It is stated that special steps are being taken by the Secretary of State for Scotland to meet the need for housing in mining areas, particularly in the new coalfields, which offer opportunities for extensive development.

Unofficial Strikes

The General Federation of Trade Unions —representing over 300,000 skilled craftsmen in various parts of the country—held its annual conference in Dundee last week, and in his Chairman's address, Mr. F. Dickinson spoke strongly on the subject of unofficial strikes. No responsible trade union official, he said, could condone irresponsible unofficial strikes, especially those which caused suffering and inconvenience to the public. They were a denial of democratic trade unionism and were anti-social in operation. Wise and well-informed trade union leaders, Mr. Dickinson remarked, undertook immediate examination of any causes of dispute and in the majority of cases, when the conferences were with reasonable employers, the causes could often be removed and stoppages prevented. If the quality of reasonableness was not found amongst the employers, then it was the constitutional duty of the union executive to take remedial action.

Mr. Dickinson suggested that, for satisfactory negotiations on wages questions it was of the utmost importance that trade union officials should be in possession of the balance sheet, the profit and loss account and the trading account of the private or public company whose representatives they had to meet. That information, he said, was necessary in order to be able to discuss the respective views on both industrial and financial questions, and to ascertain how and to what extent those accounts affected union claims.

French Engineering News

(From our French Correspondent)

PARIS, June 27th.

Reports and plans of the Nationalised Aeronautical Company have recently been published in response to numerous requests by Parliament and the Press as to what is happening in the nationalised industries. In addition to activities in connection with prefabricated houses, furniture and accessories, the company has embarked on two new types of activity, road transport and refrigeration. Construction of trolleybuses and omnibuses in light metals is a departure from the usual techniques. A first prototype has been tried in Paris, and two others are ready, one a bus for the Paris region, the other a trolleybus for Vetra. A refrigerator has also been produced, and is expected to be exported, provided the necessary authorisations and supplies are forthcoming. Although aeronautical construction remains the principal objective of the company, it has suffered from the same economic difficulties as private enterprise, and considerable credits have had to be obtained. It is pointed out that nationalised companies have the same social and fiscal expenses as private companies.

* * *

In addition to the two factories at Lievin and Bethune which produce synthetic spirit by coal hydrogenation, a third is under construction at Fuveau. The new plant will produce about 2000 tons a month, equal to the joint production of the Lievin and Bethune plants. In addition, all the gas necessary to supply Marseilles will be available. Since France is rich in neither coal nor lignite, it is unlikely that further large-scale production will be undertaken. To improve production conditions, residues will be utilised in coal agglomeration, replacing the tar formerly imported from England, Germany or Belgium. The National Research Society is dealing with the question, but tests carried out so far have not been altogether satisfactory. In fact, the president, Monsieur Audibert, states that it is impossible to manufacture tar only consuming lignite or coal and hydrogen, and that the Lievin and Bethune factories could not produce the quantity needed.

* * *

In the French electrical industry the trade of wire drawer is of special importance. These workers are meeting with increasing difficulties in the exercise of their trade and they have therefore addressed a note to the trade union council (C.G.T.) drawing attention to their difficulties. They point out that they repair and service all types of motors, transformers and radio parts. For these repairs distribution of the necessary copper is controlled by means of coupons which the workers receive quarterly. Their allocations are constantly diminishing. From 42kg per worker in the first quarter of 1946 the supply has fallen to 11kg in the first quarter of 1947. Actual requirements are about 250kg to 300kg per worker per quarter. The copper wire actually exists, because in case of need workers have recourse to the black market for additional supplies. The workers ask for a reasonable supply to meet their needs, and so suppress the obligatory practice of recourse to the black market. They also ask for a minimum delay in fulfilment of their orders by the wire-drawing mills and a longer validity for their coupons. Actual production of copper wire is greater than that of 1938, and the employment of copper is forbidden in the manufacture of new motors.

* * *

The coal seams discovered near Lyons after the first world war are no longer being worked, owing to their poor yield and the difficulty of sinking shafts through sandy ground. Against this, it is pointed out that other basins have shown such obstacles can be overcome, while borings suggest that 6m to 10m of excellent quality coal exists at a depth of between 500m and 700m. The real difficulty would appear to be to secure adequate capital to finance such a project.

Notes and Memoranda

Rail and Road

RAILWAY RADIO COMMUNICATION.—The Postmaster-General was asked in Parliament recently if suitable wavelengths had been allocated to the railways in order that modern methods of wireless communication might be used between train crews and train movement control points. A written reply stated that wavelengths had been allocated to the railway companies to cover their immediate radio communication needs. Any additional requirements, it was added, would receive consideration.

PERMANENT INTERNATIONAL ASSOCIATION OF ROAD CONGRESSES.—At a meeting of the Permanent Commission of the Association attended by representatives of a considerable number of countries and held in Paris on 19th June, it was agreed that the Association, which had been in abeyance since 1939, should resume its activities. Monsieur D. Boutet, the Vice-Chairman of the Council of Roads and Bridges of the French Ministry of Public Works and Transport, was unanimously elected President of the Association. Monsieur Naud, Inspector-General of Roads of the same Department, was elected Secretary-General of the Association.

CENTRAL LINE EXTENSION TO GREENFORD.—After an inspection last week by Mr. Alfred Barnes, Minister of Transport, who was accompanied by Lord Ashfield, chairman of London Transport, and Mr. K. W. C. Grand, assistant general manager of the Great Western Railway Company, the extension of the Central Line to Greenford was opened for service at 5.23 a.m. on Monday, June 30th. The new line will serve the Western Avenue area with which it runs parallel. Some 40,000 local residents and factory workers of Greenford, Perivale, Hangar Lane, Brentham, North Ealing, Pitshanger and Park Royal will use it. There will be a six-minute peak hour service with 292 underground trains using the line. The construction of this new extension has been carried out jointly by the London Transport and the Great Western Railway. The Great Western was responsible for the widening of its track alongside the Birmingham line and also for building the stations, bridges, viaducts and signal cabins. London Transport has equipped the line with permanent way, including a new type of jointless track, signalling and power supply, and is operating the trains. The cost of the new line from North Acton to Greenford exceeds one million pounds.

Air and Water

THE CARGO SHIP "DERRYHEEN."—The "Empire Macandrew" has been renamed "Derryheen," and has recently been reconverted by Harland and Wolff, Ltd., from a merchant aircraft carrier to a cargo ship suitable for the transport of grain and general merchandise. The contract entailed the removal of the flight deck for the full length and depth of the ship, the upper deck structure, certain hold and 'tween deck bulkheads, and all accommodation. Refitting included the installation of refrigerating chambers, new crew accommodation and new electrical equipment. The main and auxiliary machinery has been completely overhauled.

CIVIL AIRCRAFT EQUIPPED WITH RADAR.—Believed to be the first civil passenger aircraft to be equipped with radar, three Short "Sandringham" flying boats ordered by Norwegian Air Lines, are now in service on the Nothern Norway route. Each machine has one set of radar for map reading through cloud, and one set of "Rebecca," as well as radar altimeter, automatic pilot and other modern instruments. The "Sandringham" is the civil development of the "Sunderland" military flying boat. The Northern Norway route is the longest domestic air route in Europe, running from Stavangar through the polar circle to Tromso, a distance of 1165 miles.

LARGE AIRLINER PROGRESS.—The Ministry of Supply has announced that the 130-ton Bristol "Brabazon I" airliner will be ready for transfer to its specially built assembly hangar—the largest in the world—in about three months' time. The aircraft is expected to make its first flight in the spring or summer of next year. Four of these aircraft are to be built, the first with "Centaurus" piston engines and the remainder with "Proteus" propeller turbines. The "Brabazon" will be pressurised and will have accommodation for 70–100 sleeping passengers or 120 sitting passengers, in addition to a crew of 13. Of about the same weight and size, the Saunders-Roe "S.R.45" flying boat will be ready to fly in the spring of 1950, with six propeller-turbine engines.

Miscellanea

ARC WELDING ELECTRODE MANUFACTURERS.—At the recent annual meeting of the manufacturers of arc welding electrodes—a section of B.E.A.M.A.—Mr. W. W. Watt was re-elected Chairman and Mr. J. I. Law-Brooks, Vice-Chairman.

BRITISH STANDARDS INSTITUTION.—The annual general meeting of the British Standards Institution was held on June 27th, when Lord McGowan was elected President in succession to Lord Woolton. Sir Clifford Paterson, F.R.S., has been elected chairman of the general council in succession to Sir Willian Larke. The annual report and accounts show that substantial progress has been made in the preparation of British Standards for industrial products and consumer goods, and that British Standards are proving of increasing value in connection with the export drive.

THE IRON AND STEEL INSTITUTE.—The Iron and Steel Institute's special summer meeting in Zurich begins on Wednesday next, July 9th, and will continue until Tuesday, July 15th. Excursions to Geneva and Ugine or to Interlaken and Montreux will, however, follow the Zurich meeting, and will occupy from Wednesday to Saturday, July 16th to 19th. The programme in Zurich includes technical sessions on the mornings of July 10th and 11th, and a banquet in the Kongresshaus on Thursday evening, July 10th. Visits will be made during the week to several works, and for the ladies various sightseeing tours of the Zurich and neighbouring districts have been arranged.

ROYAL ENGINEER OFFICERS.—On the outbreak of war in 1939, the Royal Engineers had less than 1200 serving regular officers of which 565 were of Field rank, and above. These 565 officers produced eighty General Officers during the war, or nearly one in every seven. They held command and very high staff appointments in practically every branch of the Army. In view of the pre-war restriction upon the numbers of R.E. officers entering the Staff Colleges, and of the very great demands for officers for purely engineering appointments, it is felt that this is an achievement which should be recorded. Accordingly, *The Royal Engineers Journal* has prepared a list showing those who held General-officer rank between the declaration of war in 1939 and VJ day in 1945.

THE PROFESSIONAL ENGINEERS APPOINTMENTS BUREAU.—In order to obviate any possibility of its name being infringed, the Professional Engineers Appointments Bureau has been incorporated as a company under limited guarantee. The scope of the Bureau remains unaltered and members who, by reason of their engineering qualifications, belong to the Institution of Civil Engineers, the Institution of Mechanical Engineers, or the Institution of Electrical Engineers, or persons whose engineering qualifications for election or admission to one of those bodies have been approved by the respective Councils, are invited to register. The necessary forms may be obtained on application to the Registrar of the Bureau, at 13, Victoria Street, Westminster, S.W.1. A stamped, addressed foolscap envelope should be enclosed. Employers of professional engineers are invited to submit concise details of positions vacant on their staffs, indicating any special requirements, and stating the salary range offered.

GENERATION OF ELECTRICITY. — The official returns rendered to the Electricity Commissioners show that 3092 million units of electricity were generated by authorised undertakers in Great Britain during the month of May, 1947, as compared with the revised figure of 3237 million units in the corresponding month of 1946, representing a decrease of 145 million units, or 4·5 per cent. During the first five months of 1947 (*i.e.*, up to the end of May) the total number of units generated by authorised undertakers was 18,814 million units, as compared with the revised figure of 17,719 million units for the corresponding period of 1946, representing an increase of 1095 million units, or 6·2 per cent. The total number of units sent out from the generating stations of authorised undertakers during the month of May, 1947 (*i.e.*, units generated less units consumed in the stations by auxiliary plant and for lighting, &c.), was 2915 million units, as compared with the revised figure of 3049 million units in the corresponding month of 1946, representing a decrease of 134 million units, or 4·4 per cent. During the first five months of 1947 the total number of units sent out from the generating stations of authorised undertakers was 17,766 million units, as compared with the revised figure of 16,728 million units for the corresponding period of 1946, representing an increase of 1038 million units or 6·2 per cent.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institute of Physics

Friday and Saturday, July 18th and 19th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. A Symposium on "Methods of Crack Detection."

Institution of Civil Engineers

To-day, July 4th.—NEWCASTLE-ON-TYNE ASSOCIATION: Summer meeting in Newcastle-on-Tyne—BIRMINGHAM ASSOCIATION: Visit to Avonmouth Docks. 8.45 a.m.

Institution of Electrical Engineers

Saturday, July 26th.—N. MIDLAND STUDENTS: Summer Outing. 9 a.m.

Institution of Naval Architects

Tuesday, September 23rd to Friday, September 26th.—Autumn meetings at Portsmouth and Southampton.

Iron and Steel Institute

Wednesday, July 9th to Friday, July 18th.—Summer meeting in Switzerland.

Public Works Congress and Exhibition

Monday, July 21st, to Saturday, July 26th.—London, Olympia.

Royal Meteorological Society

Saturday, July 5th.—Summer meeting at Portsmouth.

Stephenson Locomotive Society

To-day, July 4th.—Visit to Swindon Works, G.W.R.

Personal and Business

MR. J. M. COOK has been appointed a director of Thomas Hart, Ltd.

RICHARD KLINGER, LTD., has opened a branch office and depot at 19, Queen Street, Newcastle-upon-Tyne.

MR. D. I. LESLIE DORAN, A.M.I.Mech.E., has been appointed technical officer of the Glasgow Engineering Centre.

SIR GEORGE SCHUSTER has accepted an invitation to become President of the Incorporated Sales Managers Association.

MR. J. L. ADAM has been elected President, and Dr. J. H. Paterson, Vice-President, of the Institute of Welding for 1947–48.

BROOKHIRST SWITCHGEAR, LTD., announces that its London office is now at 54, Victoria Street, S.W.1 (telephone, Victoria 7014).

MR. W. R. VERDON SMITH has been re-elected President of the Society of British Aircraft Constructors. Sir Roy H. Dobson has been elected Vice-President, and Mr. Arthur Gouge remains deputy-president.

THE ROCKWELL MACHINE TOOL COMPANY, LTD., has been appointed sole selling agent in the United Kingdom for the Le Blond Regal Centre lathe manufactured by the R. K. Le Blond Machine Tool Company, Cincinnati, Ohio.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LTD., announces that Sir Maurice Simpson and Mr. John Lamont have resigned from the board. Mr. F. W. M. Anderson, general manager, and Mr. A. H. M. Jacob, secretary, have been appointed directors of the company.

DR. D. CLAYTON, M.I.Mech.E., F.Inst.Pet., has resigned his post as officer-in-charge of the joint Ministry of Supply and Admiralty Advisory Service on Lubrication, to join the technical department of Imperial Chemical Industries, Ltd., where he will be responsible for an advisory service on lubrication and allied problems.

THE ALUMINIUM DEVELOPMENT ASSOCIATION states that Mr. W. J. McLaughlin has been appointed secretary; Mr. J. D. Beddows, chief metallurgist, has resigned; Mr. J. C. Bailey has been appointed technical officer to take over most of the duties carried out by Mr. Beddows, and Mr. P. G. Studholme has been appointed to the editorial department.

BRITISH INSULATED CALLENDER'S CABLES, LTD., announces that Mr. T. H. Martin-Harvey and Mr. Charles Pipkin have, at their own request, relinquished their positions as deputy-chairmen of the company. Mr. Martin-Harvey will continue to serve as a director. Mr. W. H. McFadzean and Mr. P. V. Hunter have been appointed deputy-chairmen.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s.	d.
B.I.O.S.			
968	Plastomers: Notes on Testing: Interview with Dr. Stocklin and Dr. Roelig, formerly of the Leverkusen Laboratories of I. G. Farbenindustrie A. G.	0	7
969	Report on Diesel Engines and Turbines: Interrogation of Dr. Ing. K. Zinner	3	2
970	German Applied Psychology	2	1
971	The Utilisation of Town Gas in Germany	4	2
982	Light Alloy Rolling, Osnabrueck Kupfer and Drahtwerke, Osnabrueck	1	1
996	Detoxification of Town's Gas at Stadtgaswerke, Hameln	0	7
607	German Wire Rope Industry	16	10
646	German Paper Machine Wire Industry	1	7
648	Ordnance Muzzle Brakes	1	1
655	Manufacture of Brushes in Germany	3	8
662	Manufacture of Phenylbetanaphthylamine at I. G. Farbenindustrie, Ludwigshafen: Antioxidan for Rubber	0	7
665	C. F. Boehringer and Sohne, Sandhoferstr, Mannheim-Waldhof: Manufacture of Vanillin, Coumarin, Anisaldehyde	0	7
666	I. G. Farbenindustrie, Uerdingen, Manufacture of Phthalic Anhydride, Benzoic Acid, &c.	1	1
671	German Linoleum and Related Floorcovering Industries	10	3
694	Magnesium Pressure Die Casting, Mahlewerk, Fellbach, Stuttgart	1	1
725	German Research on Rectifiers and Semi-Conductors	4	8
540	German Types of Heaters and Coolers for Marine and Land Applications	18	5
613	Cordage Industry	7	2
620	The German Motor-Cycle Industry	15	4
627	The Worsted Spinning Industry in the British and U.S. Zones of Germany	6	8
631	Netting Industry	1	1
643	German Anodising Practice	3	2
652	German Furnishing Fabric Industry	5	2
664	I. G. Farbenindustrie, Leverkusen, Salicylic Acid, Sodium Salicylate, Synthetic Phenol	1	1
669	Interview with Dr. Roelig, formerly of the Leverkusen Laboratories of I. G. Farbenindustries A. G.: Hysteresis machine for Rubber Testing	0	7
686	Ethylene Oxide by Direct Oxidation of Ethylene at Zweckel, I. G. Farbenindustrie	0	7
689	Interrogation of Dr. Casper, Dr. Eisenmann, Mr. Mersh, Dr. Stocklin: Plastics and Rubber	1	1
692	German Watch-Jewel Industry	0	7
693	The investigation of the Light Alloy Forging Industry in Germany	5	2
697	Fire Protection of Oil Installations in Germany	4	2
758	Manufacture of Crotonaldehyde and Crotonic Acid at I. G. Hoechst	0	7
773	Manufacture of Photographic Developing Substances at I. G. Farbenfabrik, Wolfen	3	2
123	Visits to Miscellaneous Aeronautical Establishments in the British Zone	1	7
411	Miscellaneous Electrical Factories in the British and American Zones	3	8
458 (Appendix)	Report on the Ceramic Industry in Germany	4	2
538	Report on German Patent Records	1	7
581	Hot Rolled Strip Mills	3	2
610	German Tinplate Industry	2	8
625	German Wire Rod Rolling Industry	2	8
632	German Gauge and Tool Industry	4	8
640	German Precision Chain Industry (British and American Zones only)	6	2
649	The Piel and Adey Gravity Die-casting Process: for Non-Ferrous Metals	1	1
685	German Ingot Moulds for the Casting of Steel Ingots	11	3
704	Mechanical Foam Liquid and Equipment: Fire Extinguishing	1	7
790	Armour Plate: Notes on Gas Carburising Process carried out at Krupp A. G. Essen	1	1
751	Pilot Plant Manufacture of Vinylacetylene at I.G. Hoechst	0	7
767	Accumulator Manufacture in Germany	3	8
789	Special Steels: Notes on Practice at Krupp A.G., Essen and Deutsche Edelstahlwerke A. G. Krefeld	5	2
791	Dynamic Properties of Rubber: Interrogation of Dr. H. Roelig	0	7
818	Foundries: Notes on German Iron and Steel Foundries, including Centrifugal Casting	3	8
819	Blast Furnaces: Notes on German Practice	4	8
820	Tungsten Carbide: Notes on Krupp Widia Plants	4	2
823	Steel Wire: Notes on German Wire Drawing and Steel Rope Manufacture	3	8
825	Steelmaking: Notes on German Practice	7	9
826	Investigation of German Researches on Fine Structure of Metals, with especial reference to X-ray Diffraction Techniques	2	1
42	German Oil Storage, Blending and Filling Installations: Reports on W.I.F.O. Oil Storage Depots located at Eickeloh, Ruthen and Nienberg, with particular reference to Drum and Can Filling	1	7
387	Winding Engine Manufacturers Association Report on Winding Engines in Germany: With particular reference to Koepe Pulleys. See also B.I.O.S. 136	13	10
550	Investigation of Beryllium Production in Germany and Italy, including Production and Uses of Oxides and Alloys	10	9
654	Lead-Zinc-Copper Mining in the Harz and Lead-Zinc Mining in the Ruhr Coalfield	24	0
657	German Laboratory Porcelain Industry	1	7
712	German Artists' Colour Manufacturers	1	1
728	A Survey of Certain German Manufacturers of Grain Handling, Cleaning and Milling Machinery	4	2
738	Cast Fibre Textile Machinery in Germany	1	7
F.A.A.T.			
714	Casting of Plexidas	1	1
C.I.O.S. XXXIII.			
48	Report on a visit to the D. A. G. Small Arms Factory at Stadeln, near Nuernberg: Research work on Initiators and Ingredients for Cap Compositions	2	1
F.I.A.T.			
101	Alternating Current Deck Winch built for Ms's Ostmark and Steiermark for installation at Fried. Krupp, Germaniawerft, A. G. Kiel	0	7
260	Plant of Andreas Hofer, Ltd., Muelein (Ruhr), Germany: Laboratory scale super-pressure equipment	1	1
81	Centrifugal Casting of Metals in Germany	2	1
287	Quadded Toll Cables	1	7
288	Rural Telephone Service, Dial Switching for Teletypewriter Systems and Miscellaneous items	1	7
625	Spur Gear High Pressure Pumps, designed by Egerdoefer	1	7
669	Survey of German Low Voltage Motor Control Equipment	3	8
695	Potassium Metal *vid* Thermic Reduction	2	1
115	Survey of the Carbon Brush Industry for Electrical Equipment of Germany	2	1
387	The German Steel Casting Industry	13	4
666	The Sleeve Bearing Industry of Germany	5	2
299	Supplemental Report on the Ruhrol Hydrogenation Plant, Welheim, Ruhr	1	1
409	Survey of the German Logging, Lumber and Wood Products Machinery and Equipment Industry	5	8
441	Investigation of the B.M.W. 003 Turbine and Compressor Blading	1	1
J.I.O.A.			
56	Selenium Rectifier Development in Germany	4	2
59	Synchronised Broadcasting Systems in Upper Austria: Principle of Operation	1	1
617	The Electrical and Technical Ceramic Industry of Germany	13	4

B.I.O.S. Information Section, 37, Bryanston Square, W.1., which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive inquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

100 Years of British Chemistry

As part of the centenary celebrations of the Chemical Society an exhibition illustrating the achievements of British chemistry during the past century and the part which chemistry plays in everyday life will be held at the Science Museum from July 15 to September 30, 1947. The exhibition has been organised by the Chemical Society and the Department of Scientific and Industrial Research and occupies a floor area of 10,000 square feet. The first part of the exhibition, illustrating the great advances that have taken place, includes many of the most famous objects in the history of British chemistry, collected from scientific institutions, the Universities, other museums and industrial bodies. Among famous chemists whose work is illustrated is Faraday, whose discovery of benzene in 1825 paved the way for the production of a host of new substances used in making dyes, drugs, perfumes and explosive materials. The romance of the discovery and preparation of artificial dyes is also shown, and includes W. H. Perkin's preparation of the first "coal-tar" dye "mauve," discovered in 1856. The story of the familiar electric sign is taken back to the pioneer work on the rare gases of which the red "neon" light, discovered by Ramsay in 1898, is a spectacular example. The first preparations of artificial rubber are included, and many other interesting objects in the history of chemistry during the past 100 years are shown. Each branch of chemistry has been under the care of a panel of experts composed of leading scientists of the day. A modern and popular section of the exhibition prepared by the Department of Scientific and Industrial Research deals with the applications of chemistry to everyday life. It includes sections dealing with such themes as textiles, agriculture, homes and buildings, roads and transport, fuel and power, health and food. Linking the two parts of the exhibition is a special display explaining the processes by which the chemical engineer turns raw materials into products familiar to everyone. The co-operation of the leading research associations has been secured for this part of the exhibition and the Central Office of Information has undertaken the design and layout. The Science Museum is, we may recall, open, admission free, from 10 a.m. to 6 p.m. on weekdays, including Saturdays and Bank Holidays, and from 2.30 p.m. to 6 p.m. on Sundays.

An Economic Planning Board

SPEAKING in the House of Commons on Monday evening, July 7th, Mr. Herbert Morrison, Lord President of the Council, announced the names of the members of the Economic Planning Board, and outlined the scope of the functions of that body. The Chairman of the Board, he said, would be Sir Edwin Plowden, the Chief Planning Officer, although he might have occasion to take the chair himself. The other members were Sir William Coates, deputy chairman of Imperial Chemical Industries, nominated by the Federation of British Industries and the British Employers' Confederation; Sir Graham Cunningham, chairman of Triplex Glass Company, nominated by the same sponsors; Mr. A. Naesmith, general secretary of the Amalgamated Weavers' Association, nominated by the Trades Union Council; Sir W. R. Verdon Smith, president of the Society of British Aircraft Constructors, and director of the Bristol Aeroplane Company, nominated by the F.B.I. and the B.E.C.; Mr. Jack Tanner, nominated by the T.U.C. and president of the Amalgamated Engineering Union, and Mr. H. V. Tewson, general secretary of the T.U.C., and nominated by that body; Sir John Woods, Permanent Secretary of the Board of Trade; Sir Geoffrey Ince, Permanent Secretary of the Ministry of Labour and National Defence, and Director-General of Man-Power during the war; Sir Archibald Rowlands, Permanent Secretary to the Ministry of Supply, who was at the Ministry of Aircraft Production, and served on the Viceroy of India's Executive Council from 1943-45; also Mr. A. S. Le Maitre, Mr. H. T. Weeks, and Mr. F. W. Smith, of the Central Economic Planning Committee, and Mr. R. L. Hall, Director of the Economic Section of the Cabinet Office.

An Alternative to Electricity Nationalisation

IN the course of his chairman's speech at the fiftieth ordinary general meeting of Edmundson's Electricity Corporation Ltd., which was held in London on Thursday, July 3rd, Lord Roydon outlined an alternative to electricity nationalisation. He contended that the aim of the electricity industry ought to be towards legislation for the correct type and measure of rearrangement at the right speed. This should be carried out, the industry claimed, by using properly the existing organisations suitably rearranged, namely the Ministry of Fuel and Power, the Central Electricity Board, the Electricity Commissioners, and the supply undertakings. The legislative model should be the Water Act of 1945, with a few added powers in order to ensure action. The Central Electricity Board should continue to control, but neither own nor manage generation. The Electricity Commission should be strengthened as a body, enabling it to enlist a higher quality of personnel, through payment of commercial scale salaries. It should also have wider powers, including the powers of compulsory amalgamation. The advantages of such a plan over nationalisation would be, he said, the consolidation of areas under existing ownership tending to reduce costs; the avoidance of inevitable delay and general dislocation, which nationalisation will bring about; the preservation of competition between electricity and gas, and the healthy rivalry which exists between undertakings. Business management would continue, thereby avoiding the dangers of political patronage, and finally the electricity industry would remain independent, and would not be chained to gas and coal and possibly be called upon to make good their losses, as might well happen under nationalisation.

Institution of Civil Engineers Summer Meeting

THE first post-war summer meeting of the Institution of Civil Engineers took place at Newcastle-upon-Tyne on Thursday and Friday last week, July 3rd and 4th. Some hundred members and students and their ladies took part. The proceedings opened on the evening of Wednesday, July 2nd, by an informal assembly at the Royal Station Hotel. On Thursday morning an official welcome was given at a meeting held in the Physics Lecture Room at King's College by the Lord Mayor of Newcastle-upon-Tyne, and Lord Eustace Percy, the Rector of King's College. Two papers read included one by Mr. R. F. Hindmarsh, M. Inst. C.E., on "The Tyne: An Account of its History and Development," and another by Mr. A. Floyd, B.Sc., M. Inst. C.E., on "The Engineer's Place in the Community," and discussions followed. In the afternoon a trip was made on the Tyne Improvement Commissioner's launch, and the river was inspected from Newcastle to North Shields. Visits of inspection were also made to the Walker Naval Yard of Vickers-Armstrongs Ltd., the works of C. A. Parsons Ltd., at Heaton, and to the Dunston power station of the North-Eastern Electric Supply Company. In the evening a dinner and musical entertainment was offered at the Royal Station Hotel, the party being received by the President, Sir William Halcrow, and the Chairman of the Newcastle and District Association, Mr. Percy Barr, the City Engineer, Newcastle, and Mrs. Barr. Friday, July 4th, was devoted to visits to places of interest. Roman remains and a Roman bridge were inspected under the guidance of Dr. I. A. Richmond, of King's College, and visits were made to the Port of Sunderland, the Pyrex Glass Works, the new Sunderland power station, and the I.C.I. works at Billingham. The meeting terminated with a civic reception at Tilley's Rooms, at which the party were entertained to tea by the Lord Mayor. During the meeting the engineering laboratories of King's College were open to inspection, and there was an exhibition of drawings by the students in the College. A very happy meeting was spent.

The Late Mr. Robert Sinclair Kennedy

MARINE engineers and naval architects interested in welding will learn with deep regret of the death at his home, Jericho, Oundle, on Wednesday, July 2nd, of Mr. Robert Sinclair Kennedy, late of Ferring, Sussex, who for over twenty-eight years was the managing director of the British Arc Welding Company, Ltd., of Royal Albert Docks, London, E.16. Mr. Kennedy, who was seventy-three years of age, received his technical training at University College, London, and was Senior Gilchrist Scholar. He served his apprenticeship with the North-Eastern Marine Engineering Company at Wallsend, with Glenfield and Kennedy of Kilmarnock, and Clarke Chapman and Co., Ltd., of Gateshead. After some seagoing experience, he worked with various shipbuilding and engineering firms in the capacity of draughtsman. In 1897 he was appointed assistant manager to the Glengall Iron Works, Ltd., of Millwall, London, and became managing director of that firm. He then joined the British Arc Welding Company and was one of the pioneer workers on welding with the metallic electrode in this country. For more than a quarter of a century, Mr. Kennedy, took a leading part in the development of arc welding and became managing director of his company, retiring in 1943. He was an early member of the Institution of Civil Engineers, and the Institute of Marine Engineers. He served on the Council of the Institute of Marine Engineers from 1918 and was re-elected for the periods 1921 to 1923 and again from 1925 to 1927. He was Chairman of Council from 1926 to 1927 and was Chairman of the Membership Committee from 1933 to 1945. In 1928 he was elected Vice-President and this year he was made Honorary Vice-President.

Certification of Electricity Meters

IN a circular letter dated July 3rd and addressed to all authorised electricity undertakers, the Electricity Commission states that steps are being taken to secure the repeal of Defence Regulation 60 C B (Suspension of Certification of Electricity Meters) with effect from October 1, 1947. This means that after the Regulation has been revoked it will be obligatory for all meters installed, otherwise than by special agreement, to be certified and that ordinary consumers will have the right to require a certified meter. When normal certification procedure is resumed after the revocation of Regulation 60 CB it is anticipated that meter examiners will deal with all certification requirements during the periodical visits to undertakings, but the Commissioners will be prepared to continue for the time being postal certification in cases of exceptional urgency. In such cases the meter examiner may at his discretion require the undertakers to keep back for test a percentage of the meters submitted before he signs the certification forms. Certification of meters at the meter manufacturer's own testing stations will continue to be permissible for the time being. The Commissioners have reviewed the relaxations permitted by them during the war period and have decided that the normal testing of apparatus and the approved methods of testing meters should now be resumed. These relaxations are, therefore, now withdrawn, subject to certain exceptions which are specified in the Commission's letter of July 3rd.

Lighthouse Engineering

By K. C. SUTTON-JONES, Stud. Inst.C.E.

No. I.

THE question may well be asked: "Why Lighthouse Engineering?" "Is not a Lighthouse or Lightvessel basically optical in character?" This is so—but it also utilises electricity, mechanical science is introduced, civil engineers construct the towers and buildings, marine engineers design the lightvessels and, latterly, radio engineers are having their say in the all-important undertaking known as "Lighthouse Engineering." Almost every branch of engineering is employed in providing this essential indication to the mariner. The combination of the branches has varied application in order to produce the many forms of sea marks: gigantic wave-swept lighthouses have been erected to mark such dangers as the Eddystone Rocks to the south-west of Plymouth. Lights of extreme power have been introduced to assist the mariner in "making a landfall," such as at the Lizard—the southernmost point of England. Lightvessels ride the storms to provide indication where a lighthouse cannot be built. Beacons and portlights mark entrances to small harbours, promontories and rocks, whilst estuaries are divided in channels by buoys.

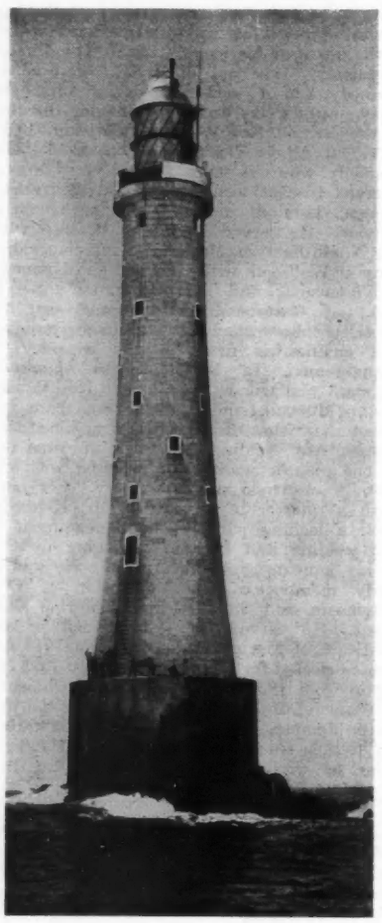


FIG. 1—BISHOP ROCK LIGHTHOUSE

Whilst the nature of sea-swept lighthouse sites continues to demand the erection of granite towers on account of the essentials of strength and weight, there is now a widespread use of reinforced concrete, although disintegration of the reinforcement is still considered a major defect in such structures.

Until comparatively recently, lightvessels were little more than floating hulks, carrying "an apology" for a light. Even during the period of great optical advancement (late nineteenth century), little was done to improve the optical apparatus aboard lightvessels. Lightvessels of today, however, are veritable floating-lighthouses, and are equipped with electrical machinery and with semi- and fully-automatic control features incorporated.

Small harbour lights and beacons are now becoming as reliable as larger lights, and for this purpose the use of acetylene-operation is well known—but many novel features are now being introduced.

Whilst gas-operated buoys remain much the same in principle, electricity has been employed successfully in buoys notably in the United States of America and latterly in Britain.

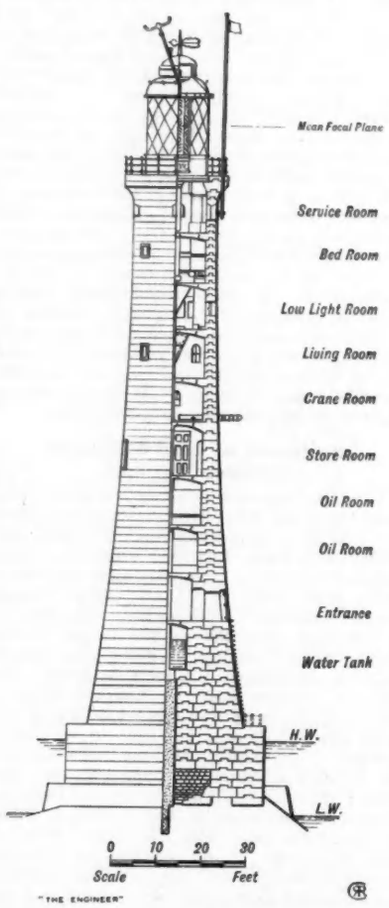


FIG. 2—SECTIONAL ELEVATION OF EDDYSTONE LIGHTHOUSE

It will be obvious that, apart from its power, the range of the beam emitted by a lighthouse depends upon its elevation above sea level, and the height of the observer above sea level. In the case of a lighthouse out at sea on a submerged rock, such as the Eddystone, it has been necessary to build a tower of some 140 feet height in order to give to the light a range of eighteen miles. In the case of a lighthouse situated upon a cliff top, it becomes necessary to build a comparatively low tower structure only, unless exceptional range is desirable. It is generally agreed that the luminous range of a light (in the average weather conditions at the site) —that is the range it has by virtue of its intensity—should reach the horizon. This puts a limit to the height at which the light should be exhibited. It has also been found in a number of instances that cloud obscures a cliff-top at times when the lower regions (nearer sea level) remain unobscured. One might have questioned the erection of the Beachy Head Lighthouse at the foot of the cliff, whereas, if the lighthouse had been built upon the cliff-top, the light would have been elevated to some four or five times its present height. The facts reveal, however, that whilst clouds often obscure the cliff-top, the level to which the tower elevates the light remains unobscured.

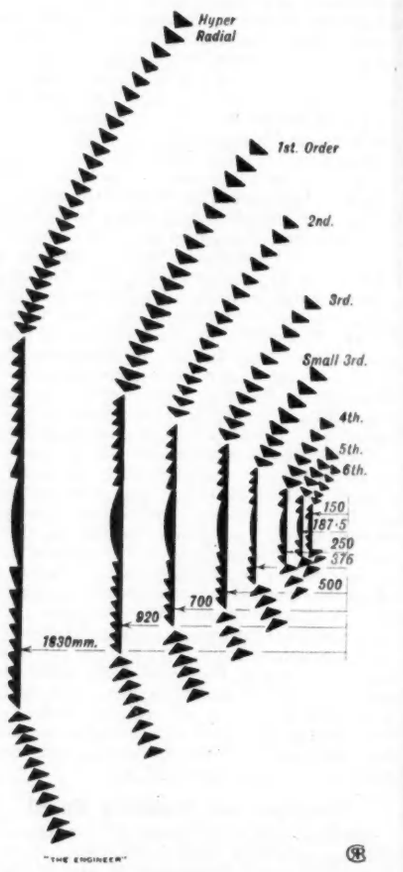


FIG. 3—OPTICAL SECTIONS AND SIZES AS USED IN LIGHTHOUSES

The forces to which sea-swept towers are subjected are enormous—Bishop Rock, Wolf, Longships, Eddystone, and many other lighthouses are sometimes almost completely smothered by sea during the winter months. Thus, to provide both weight and strength, these towers have been constructed of granite blocks dovetailed one into the other—the lowest course being set into the rock itself. The forerunner of our present construction methods was first adopted in the tower erected on the Eddystone Rocks by John Smeaton, in 1759. This tower had a curved, tapering exterior, and whilst many towers were

built in this manner, notably in Scotland, Sir James Douglass, past Engineer-in-Chief to the Trinity House, adopted a cylindrical base (on the new Eddystone structure), which has the action of breaking-up the waves at a low level and also serves as a convenient platform for relieving the lighthouse. This principle was further adopted at Bishop Rock (see Fig. 1), whilst, for the Wolf Rock Lighthouse, another method was adopted consisting of a number of "stepped" lower courses, a system which also has the action of breaking the waves at a low level. In Britain it has been common practice to build sea-towers solid to a height of some forty feet above high water level—at which elevation the entrance room forms the lowest of a series of rooms—the lantern surmounting all. (See Fig. 2.)

Towers on islands and on promontories are now often constructed in reinforced concrete, or are of the openwork type, whilst those situated upon sandbanks are also usually of the openwork type, fixed to the sand by screw piles.

Optical Apparatus

Great strides have been made in lighthouse engineering generally, during the past century, and vast changes in signalling

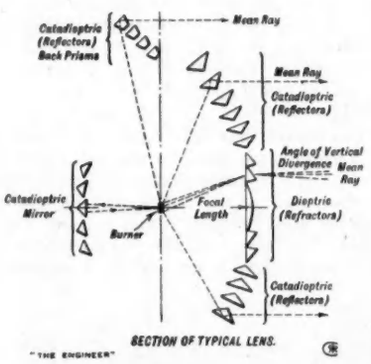


Fig. 4—Section Through Typical Optical Apparatus

equipment have been witnessed, particularly in the optical sphere. The brilliancy of modern lightsources has brought about a tendency to reduce the size of the optical condensing unit—high intensities being now obtainable from comparatively small optical apparatus incorporating lightsources of high power. This restriction in the size of optical apparatus resolves into smaller lanterns being required and the need for smaller towers. These tendencies have been brought about largely by the introduction of electricity, which also has enabled engineers to introduce many automatic-control features so that lighthouses and lightvessels can now be classified as fully-attended, semi-automatic, or unattended in operation.

Two optical types are generally employed: known as catoptric and catadioptric, respectively, whilst a third, known as dioptric, is used in small equipment. The catoptric system embodies the use of silvered reflectors and whilst the reflecting property of such surfaces is favourable there are many disadvantages. The apparatus is inefficient to a considerable degree in that only a portion of the light emitted by the lightsource is reflected by this means—the remainder, in the direction of the reflected light, is not condensed by the reflector. Silvered surfaces are apt to deteriorate in salt atmosphere more rapidly than do catadioptric condensing agents. Arrangements of the catoptric system are applicable mainly to lightvessels and will be dealt with in the next article in this series.

The catadioptric system embodies the principles of refraction and reflection. In a lighthouse lens of "fixed" section—rings of prismatic refracting glass are arranged around the vertical line through the lightsource, thus condensing the light emitted by the latter into a horizontal fan-shaped beam measuring the height of the lens and the horizontal angular subtense of the lens at the source of light. Further rings of prismatic glass utilising refraction and reflection are arranged below and above the refracting elements so that a high proportion of light emitted from the lightsource is condensed into the horizontal plane. The term "dioptric" is applicable where refracting agents only are employed.

Lighthouse "optics," as they are termed, are classified into sizes or "orders," depending upon the focal length of the central "bull's-eye" or "belt." The largest type of lens is one of 1330 mm focus (9ft diameter), whilst the smallest of the "orders" class is of 150 mm focus (almost 1ft diameter). (See Fig. 3.)

The revolving lens as generally employed today consists of a number of lens-panels which condense the light emitted by the lightsource into a number of pencil beams. Each panel is composed of refracting and reflecting prismatic glass rings and segments generated around the horizontal axis through the "bull's-eye" (see Fig. 4). The character or period of flash of the light is produced by the revolution of the whole assembly of panels about the vertical axis through the lightsource.

In the case of single flashing characters, the angles in the horizontal plane between panels are equal. With groups of flashes recurring periodically, the angles between the panels in a group are equal. A wide angle separating the last and first flash panels produces the "eclipse" period.

The light emitted by each lens element is made to "dip" to the horizon. Thus, although the height above sea level of a powerful light restricts the direct luminous range (to some twenty-three miles in the case of Lizard Lighthouse), the distance at which "loom" or light reflected by the upper atmosphere has been seen exceeds eighty miles.

Marine lights are now being used by aviators, and to facilitate this special prisms have been designed for fixing in front of the main optic panels. These prisms are contained in a small panel and diverge about 10 per cent of the light emitted from the marine panel upward, to exhibit a character to the aviator identical with that exhibited to the mariner. This is illustrated in Fig. 5.

In modern practice, optics are designed to rotate more rapidly than of late. This means that fewer optic panels are required to produce the character—which, in turn, increases the area of panels and results in a higher intensity per flash. The increase is not proportional to the increase in area, however, because the flashing intensity of a light decreases with the speed of revolution of the apparatus. The speed of rotation is also limited by a general agreement that stipulates a minimum duration of flash of 0·3 sec. (The duration of flash is a function of the width of the lightsource, the focus and the speed of rotation of the lens.) Thus, modern lighthouse optics are of comparatively small diameter, comprise few, but wide-angled panels and incorporate small but intense lightsources. The lighthouse engineer has thus brought into service apparatus which is both economical in operation and

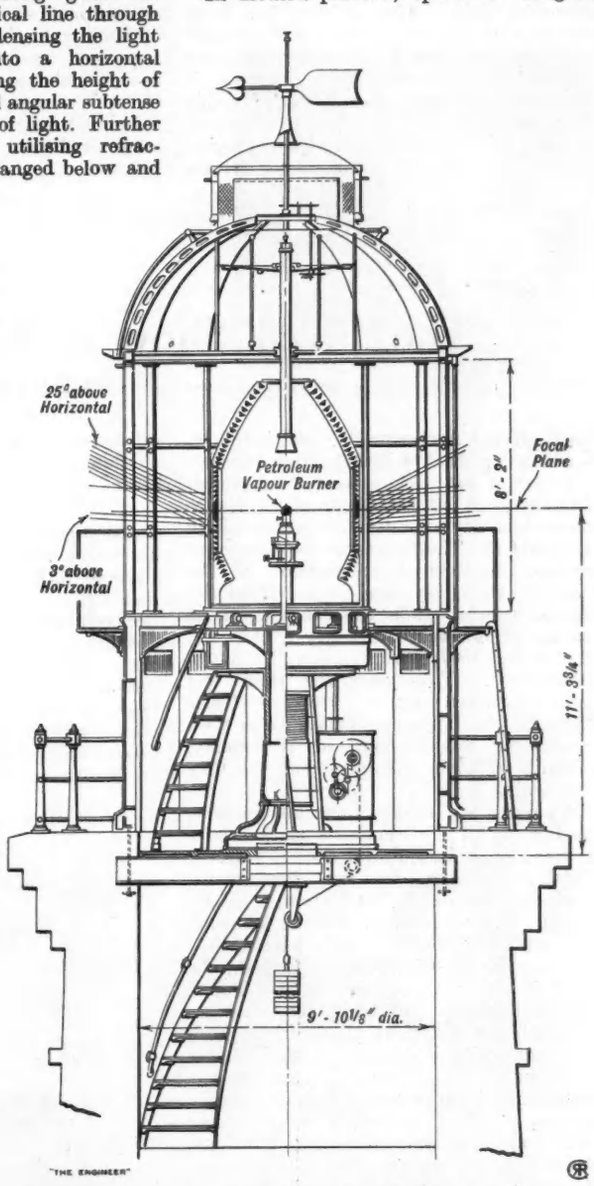


Fig. 5—Section Through Typical Lighthouse Showing Marine and Aerial Optic Characteristics

capital cost and suited to the needs of the mariner, although many consider that large optic panels aid conspicuity on account of the increased angle of perception.

In the past it has been necessary to overcome limitations imposed by the diameter of the towers in order to accommodate lenses of the largest calibres. With high-powered lightsources this difficulty does not often arise. The problem has been overcome by the introduction of "biform," "triform" and "quadriform" arrangements in which optics are superimposed—each subtending its separate lightsource. Notable lenses of "biform" type are installed at Bishop Rock, Eddystone and Fastnet lighthouses. The placing of optics of certain types side by side also has had application, notably at Lowestoft lighthouse.

In light stations on the shore it is usually found unnecessary to exhibit the light shorewards, which has enabled use to be made of a certain arc on the shoreward side of the lightsource. It is often found that various outlying rocks have to be "covered" by sectors (sometimes coloured), and these are produced, in some cases, by the projection of light from the unused arc in the main apparatus downwards through the lantern floor and thence through a window into the direction required. Nowadays this arc is found convenient for placing the standby lamp or burner supported by the lamp-changer.

(To be continued)

The Royal Show at Lincoln

No. II—(*Continued from page 8, July 4th*)

THE Royal Agricultural Society's Show, which was held at Lincoln from Tuesday to Friday of last week, attracted big crowds of visitors each day, and the total attendance on the four days is estimated to have been over 240,000. The last show took place at Windsor in 1939, in celebration of the Society's centenary, and was visited by 118,036 people, while the attendances at the two shows held previously at Lincoln, in 1854 and 1907, were 37,635 and 133,036, respectively. This year, the show was again honoured by a visit of Their Majesties the King and Queen, who were present for several hours on Wednesday, following a Civic Reception in the City of Lincoln.

Reference was made in our last issue to the fact that there were over sixty entries in the Royal Agricultural Society's Silver Medal competition for new implements. The judges were Mr. C. B. Chartres, M.I.E.E., and Mr. H. Cole Tinsley, and the following fourteen Silver Medal awards were made: Aldersley Engineering Company, Ltd., for the "Aldersley" grain drier; E. Allman and Co., Ltd., for "Speedesi" crop duster; the Butterley Company, Ltd., for a green crop loader; Gascoignes (Reading), Ltd., for a vacuum milk cooler; Humberstone Agricultural Products Company, Ltd., for a rowcrop tractor; Johnson's (Engineering), Ltd., for a potato harvesting machine; H. Leverton and Co., Ltd., for a pea cutter; Markjohn Mechanical Spreaders, Ltd., for an Electric lime spreader; Massey-Harris, Ltd., for an 8ft combine harvester; "One-Man" Mechanical Lorry Loader Company, for a lorry-loading machine; Pest Control, Ltd., for an acid sprayer; Wolseley Sheep Shearing Machine Company, Ltd., for a turbulent milk cooler; M. B. Wild and Co., Ltd., for a muck spreader, and J. Woolley and Co., for a heat-storage dairy steriliser.

With regard to the following entries, the judges deferred their decision till next year so that further tests of the machines may be made: H. Leverton and Co., Ltd., potato and root shaker-digger; Modern Designs, Ltd., Packman potato harvester; Salopian Engineers, Ltd., universal elevator; Sarum Poultry Houses, field poultry house; Transplanters (Robot), Ltd., three-row potato planter, and M. B. Wild and Co., Ltd., harvest-thresher.

We continue below descriptions of some of the implements and machines which were exhibited at the show.

M. B. Wild and Co., Ltd.

A departure from the normal run of grain-harvesting machinery was to be seen on the stand of M. B. Wild and Co., Ltd., Nechells, Birmingham. It is known as the McConnel Bomford harvest-thresher, and as it is towed through a field of corn it removes the grain from the heads and disposes of the chaff, leaving the straw and empty heads standing. When at work, the machine is offset to the tractor and takes a 50in width of crop, only its corn-side wheel actually passing through the unthreshed corn. The machine is in effect a threshing unit mounted, with its own air-cooled engine, on a tubular steel frame. The frame is carried on two widely spaced land or rubber-tyred wheels at the rear and on two closely set pivoted wheels at the front. A tow-bar is attached to the axle of these front wheels and the machine is sufficiently light to be towed by a medium-powered tractor.

The crop to be harvested is led into the threshing unit by dividers or guide fingers, which are mounted on the front of the drum casing. These dividers conduct the ears of corn to the threshing rotor, which consists of a series of discs mounted on a shaft, each disc carrying radial vanes. The vanes are staggered on adjacent discs, and as the rotor is revolved the staggering causes the corn ears to be beaten rapidly from side to side, thus detaching the grain and the chaff. The rotor also acts as a fan, creating enough draught to blow the grain and chaff into the swirl chamber, which is cylindrical in shape, with an extension funnel on each end. The grain, on account of its greater weight, collects in the swirl chamber and falls into the bagging chute, while most of the chaff is blown out through the funnels. The swirl chamber and funnels, it may be noted, are removable as a complete unit to enable the machine to travel along narrow lanes. The swirl chamber has two outlets at its base on to a bagging platform on which the operator sits. Each of these outlets is fitted with a shutter, so that full sacks may be removed and replaced by empty ones without loss of grain. A view of the harvest-thresher, showing the bagging platform, is reproduced in Fig. 8, while the diagram, Fig. 9, indicates the principle of operation.

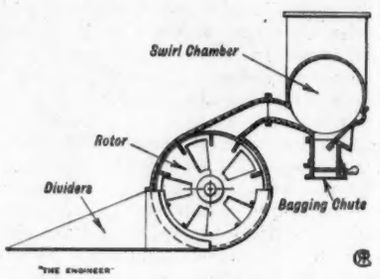


FIG. 9—OPERATION OF HARVEST-THRESHER—M. B. WILD

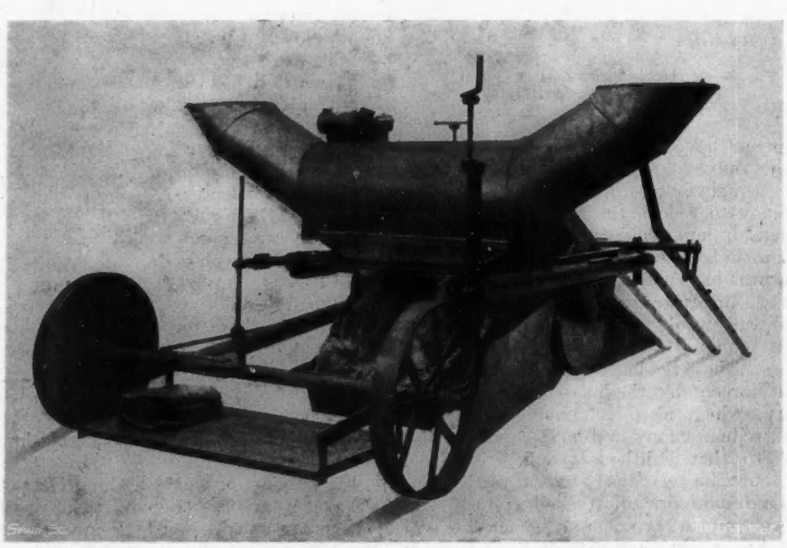


FIG. 8—HARVEST-THRESHER—M. B. WILD

The threshing rotor is belt driven from an air-cooled J.A.P. petrol engine, developing a maximum of 4·3 h.p., which is fitted with a governor to ensure constant speed of the rotor during threshing. A control is provided so that the preset speed of governing can be varied, and a centrifugal clutch is fitted between the engine and belt drive in order that the threshing rotor may be freed

from the engine when it is being started or throttled back while running.

It may be added that the threshing unit is adjustable vertically to suit the height of the crop being worked, the range enabling crops between 18in and about 5ft in height to be handled. Crop lifters are also provided for dealing with laid corn and to prevent the dividers from becoming choked with loose straw or other rubbish.

Penney and Porter (1932), Ltd.

Corn drying and grading have become of considerable importance since the introduction of the combine harvester in this country. Because of our climate, corn harvested by the combine nearly always contains an excess of moisture, which must be driven off if deterioration of the grain in storage is not to take place. The average excess of moisture is 5 to 6 per cent.

The "Lincoln" corn drier in conjunction with a pre-cleaner and a "Winnowgrader" grading machine designed and shown by Penney and Porter (1932), Ltd., of Riverside Works, Lincoln, provides complete equipment for cleaning, drying and grading corn. The "Winnowgrader" machine has been entered for the R.A.S.E. Silver Medal at the Show. Our illustration, Fig. 10 shows the corn drier on the right and the grader on the left-hand side, whilst another view of the grader is reproduced in Fig. 11 It is usual to arrange the lay-out to provide for a pit of ample capacity to receive the crop from the combine harvester. From this pit the corn is elevated to the pre-cleaner, a relatively simple arrangement of screens and blower which eliminates dirt, small seeds, short straws, thistle bolls, and other extraneous matter. The grain is then taken from the pre-cleaner to the top of the dryer by an elevator, whence it passes by gravity through the drying tower, the vertical cylindrical component shown in Fig. 10.

Drying is accomplished by passing a current of hot air through the grain as it passes slowly down the tower. After passing through the hot air section, the grain is cooled by a stream of cold air. The drier is therefore equipped with a furnace, a hot air fan, and a cold air fan, and suitable arrangements for varying the speed with which the corn is passed through. Motive power is usually provided by a farm tractor, which can work the whole plant. If electricity is available, a 10 h.p. motor is recommended for the drier and a 5 h.p. motor for the grader and pre-cleaner. The furnace may be fired by coke, in which case thermostatic control can be incorporated or it may be oil-fired. Alternatively, electricity may be used for heating the air, with advantage, but costs are usually high. The firm quotes average costs for drying based on data of the 1945 harvest as 9d. per ton of grain dried, using coke at 60s. per ton; 2s. 2d. per ton using oil at 10½d. per gallon, and 10s. per ton using electricity at 1d. per unit.

Grading of the corn received from the drier is effected in stages, in the "Winnowgrader," of which the delivery side is shown in Fig. 11. In this machine the grain is first passed through a blower to take out light dockage, such as straw chaff, then passed over flat riddles to remove large waste, such as poppy heads, after which it is elevated and finally passed through the grading drum, where the corn is separated into three grades. A fine degree of adjustment is provided for the wire mesh of the grading drum. Grain issues from the machine through feed spouts, one for each grade. From the time the grain enters the machine to the time it issues for bagging the grading process is automatic.

British Motor Boat Manufacturing Company, Ltd.

Three different sizes of light ploughing and cultivating tractor were shown on the stand of the British Motor Boat Manufacturing Company, Ltd., of Britannia House, Ampton Street, W.C.1. They represent a range of equipment suitable for the requirements of smallholders, growers, crofters and market gardeners, and are all of the type where the driver walks behind the machine and steers it by handlebars. The smallest, the 1½ h.p. "Hoe-Mate," is designed for speedy row crop work, whilst the 3 h.p. "Cult-Mate" and 6 h.p. "Plow-Mate" are for heavier and deeper cultivations and ploughing.

Fig. 12—"Cult-Mate" 3 h.p. Light Tractor—B.M.B.

We illustrate in Fig. 12 the 3 h.p. "Cult-Mate," on rubber tyres. Steel wheels can readily be fitted as an alternative. The tractor is driven by a single-cylinder four-cycle air-cooled engine through gears running in oil, with a final drive with over-running ratchets in each wheel to give a differential action. Speed can be controlled from ½ to 2½ m.p.h. by the throttle and adjustable governor. Ground clearance is 13in and the overall height is 2ft 11in. Fitted with the standard metal wheels the machine weighs 483 lb.

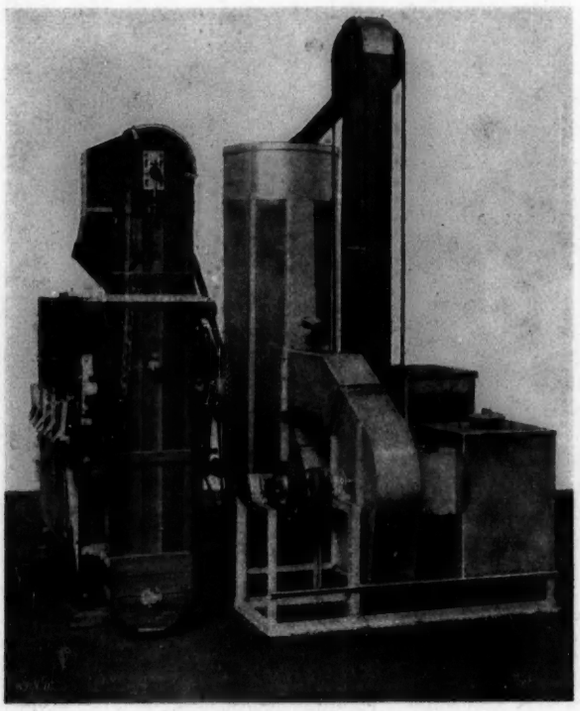


Fig. 10—Corn Drier—Penney and Porter

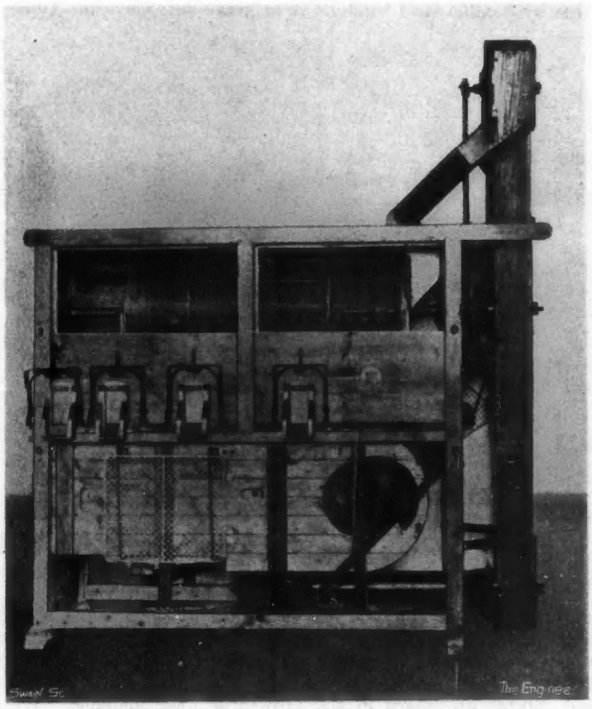


Fig. 11—Corn Grading Machine—Penney and Porter

A comprehensive range of implements is available for use with this tractor, including an 8in semi-digger plough, a set of disc harrows, comprising two gangs of three discs, 14in in diameter, for breaking down heavy ground and seed bed preparation, a spike-tooth harrow, a spring-tined harrow, and various cultivators. With a power take-off pulley as additional equipment, the 3 h.p. available can be utilised to drive a concrete mixer, grinding mill or any other machinery. The change from plough to implement or from one implement to another is designed to be done in a matter of minutes, as it requires only the removal of two bolts.

E. Allman and Co., Ltd.

Scientific farming has brought about various methods for dealing with land and crop infestation, and E. Allman and Co., Ltd., Chichester, exhibited several examples of the "Speedesi" crop duster. We have chosen for description the machine illustrated in Fig. 13, which is the standard dusting unit produced by the firm, and which gained a Royal Agricultural Society's Silver Medal. Its main frame is of steel plate, and it can be used with almost all types of farm and market garden tractor. A large-capacity hopper is provided which is made of specially treated lead-coated sheet steel in order to resist corrosion. A control, easily reached from the tractor seat, starts and stops the flow of powder, and a graduated scale on the top of the hopper enables the operator to estimate visually the quantity of powder being used, so that he may regulate the flow accordingly.

The power for operating the duster is supplied by the exhaust gases from the tractor engine, the gas being conveyed to the machine by flexible steel tubing. A height-regulating frame is mounted on the main frame of the "Speedesi," and by means of finger-tip control and ratchets the dusting unit can be set so that dusting can be carried out at all stages in the growth of crops.

Fig. 13—"Speedesi" Crop Duster—Allman

Johnson's (Engineering), Ltd.

The harvesting of a potato crop is one of the more laborious farming tasks if done by hand, and considerable progress has been made in recent years in the production of machines which can eliminate much of the hand work hitherto required. One such machine was exhibited at Lincoln by Johnson's (Engineering), Ltd., March, Cambs, and a photograph of it is reproduced in the engraving, Fig. 14. This potato harvester, which is power driven from a tractor, is mounted on four wheels, the rear two being fitted with rubber tyres. The centre pivoted front axle has been designed, the maker states, with a view to ensuring a constant depth while the machine is at work.

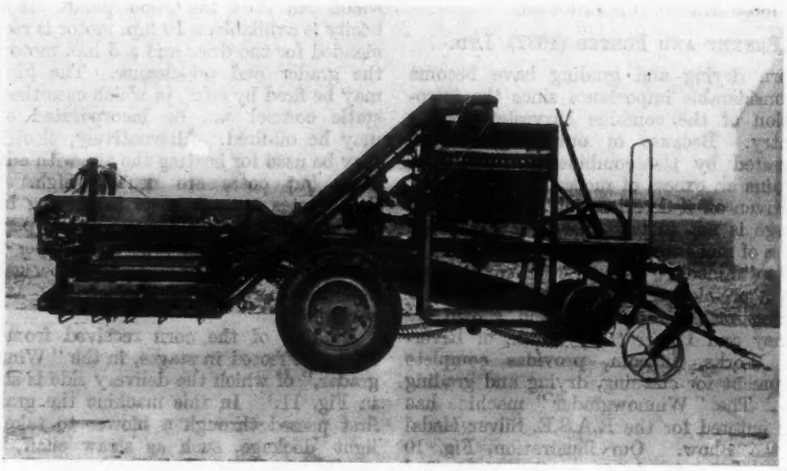


Fig. 14—Potato Harvester—Johnson's

The actual lifting of the potatoes is performed by a share with adjustable discs operating alongside. These discs can be adjusted to meet varying soil conditions and to ensure that the potatoes are deposited on a digger chain which is similar in design to an elevator type chain. The potatoes, together with haulm, are carried to an open-mesh conveyor, through which the clods of earth and similar deleterious matter pass, while the haulm is carried over the back of the machine. The potatoes are then lifted to a convenient height by rubber-covered conveyors on to a rubber-covered riddle, and through this the small potatoes, stones and clods drop into a hopper. The ware potatoes travel along a flat sorting conveyor, from which the larger lumps of earth may be removed and the clean potatoes delivered into trailers travelling alongside the machine. The makers, it should be added, have been awarded a Silver Medal for this potato harvester in the "New Implement" competition.

Transplanters (Robot), Ltd.

Among the machines for planting and harvesting root crops was the Robot three-row potato planter, exhibited by Transplanters (Robot), Ltd., Sandridge, Herts. This machine, illustrated in Fig. 15, was entered for the Silver Medal competition, and the decision as to an award was deferred until next year so that further tests may be made. It has been specially adapted for use with the Fordson Major tractor, and is driven from the power take-off. Its tool bar can be arranged to carry either coverers or ridging discs, as required. This machine, however, does not include the fertiliser distributor incorporated in other planters produced by the firm.

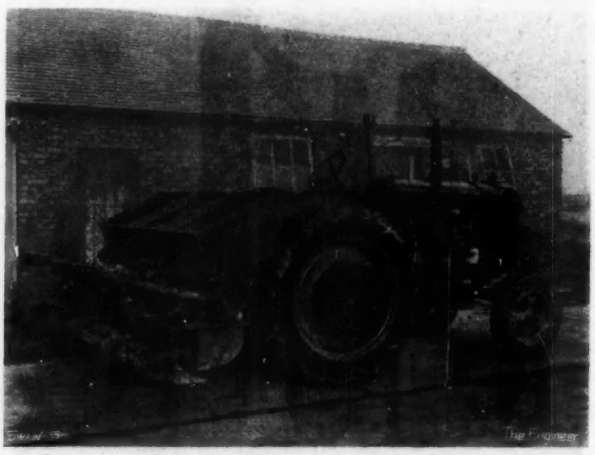


Fig. 15—Robot Potato Planter—Transplanters

A large seed hopper holding 5cwt of potatoes is provided, and three operators seated at the rear of the machine direct the seed to the feeder cups. The depth of planting is controlled by an adjustable arm resting on the tractor draw-bar frame, the adjustment being in ½in steps. The drive from the power take-off is transmitted to a 40 to 1 reduction gearbox, sprockets giving spacings in planting of approximately 10in, 14in, 18in, 20in and 24in. Row widths of 24in to 30in may be obtained by shifting the two outer planting units, which can be moved complete.

This firm also exhibited a Robot trans-

planter, which, it is claimed, is capable of handling plants from 4½in to 18in overall length at a rate of up to 12,000 an hour.

THE FISHLEIGH ROTARY CULTIVATOR COMPANY, LTD.

A tractor-drawn rotary cultivator, which, it is claimed, can be used satisfactorily at all seasons of the year, was shown on the stand of the Fishleigh Rotary Cultivator Company, Ltd., of Barnstaple. This machine may be employed for clearing stubble and weeds in the autumn, and for imparting a fine tilth in the preparation of seed beds, while during the winter time it can be used for renovating grassland.

The engraving, Fig. 16, shows a rear view of the cultivator, the principal operating part of which consists of a set of curved steel tines which are adjustable for depth and are arranged spirally on an axle. The axle is geared to driving chains receiving power from the tractor through an adjustable gear-box, and when at work the tines rotate in the same direction as the wheels of the cultivator carriage. With a view to preventing any sudden extra strain from damaging the power transmission, "overload" clutches are provided which can be adjusted to any condition of ground.

The carriage, which is mounted on steel wheels, is fitted with a steel hood with a hinged cover. During any land-clearing operation, this hinged cover is raised so that the earth, weed and stubble lifted by the rotating tines are flung upwards and backwards. The heavy earth falls first, the weeds and other waste matter being left on the surface.

BARFORD (AGRICULTURAL), LTD.

A new implement which was entered for the Royal Agricultural Society's Silver Medal by its designers and manufacturers, Barford (Agricultural), Ltd., of Grantham, a subsidiary of Aveling-Barford, Ltd., is a tractor for horticultural work known as the "Atom" tractor. It is a small petrol engine-driven, hand-guided machine, to which various implements can readily be fitted. The tractor (Fig. 17) was shown with cultivator and tines; expanding tool holder and hoes; disc harrow and holder; ridging plough; 3ft grass cutter, and hedge clipper and generator. The grass cutter is operated from a power take-off

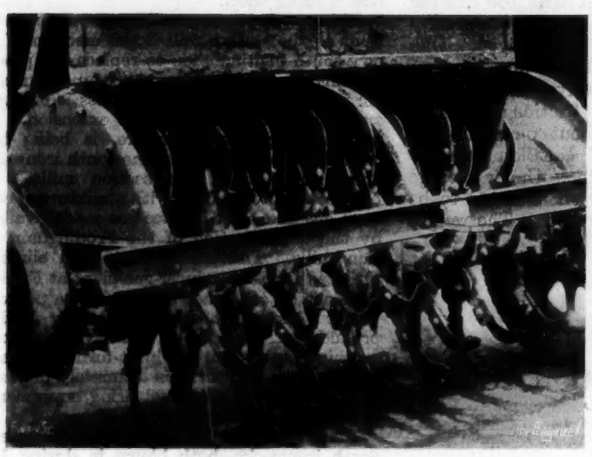


FIG. 16—ROTARY CULTIVATOR—FISHLEIGH

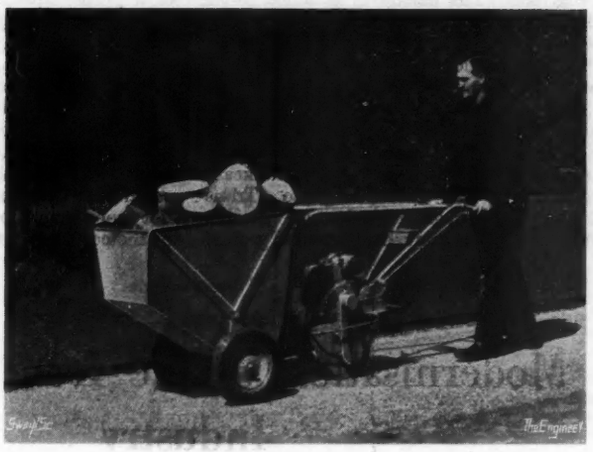


FIG. 18—"ATOM" TRACTOR AS WHEELBARROW—BARFORD

FIG. 17—"ATOM" TRACTOR WITH HOE BLADES—BARFORD

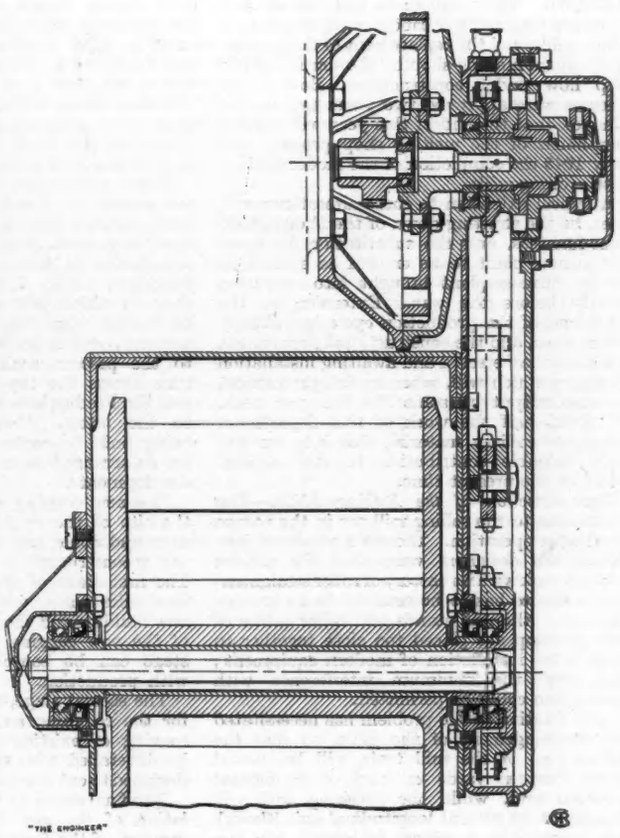


FIG. 19—SECTION THROUGH TRANSMISSION UNIT—BARFORD

and can be quickly and rigidly mounted on the front of the machine. The hedge clipper consists of a small trolley carrying a generator, driven from the tractor power take-off. Current is fed through a 40ft cable to a small electric motor operating a 12in cutter bar with reciprocating teeth. Another use for the tractor is to convert it to a mechanical wheelbarrow, as shown in Fig. 18. The barrow is attached to the front of the tractor and is braced to the tractor handlebar cross member. It is designed for a load of 3 cwt, has a tipping body, and is mounted on pneumatic wheels.

Power for driving the tractor is supplied by a 98ccm four-stroke petrol engine, cooled by a cowled fan and lubricated by splash from an oil sump under the crankcase. Ignition is by "fly-wheel" magneto. Transmission is through a reduction gearbox with machine-cut gears, hardened and ground, totally enclosed and running in oil. On the side of the reduction gear case is a power take-off, revolving at 600 r.p.m. The tractor is propelled by a single driving wheel or roller rotated by a chain drive. The third illustration, Fig. 19, reproduces a sectional drawing of the reduction gearbox and driving wheel. It may be noted that the chain drive is adjustable by means of a jockey sprocket and that the driving wheel, which may be of two alternative types, can quickly be interchanged. One is designed to be suitable for operating on grass and the other on cultivated land. The machine is controlled by a friction clutch and works at a speed of about one mile per hour. A petrol tank of $\frac{1}{2}$ gallon capacity is carried behind the engine. Under average conditions fuel consumption is stated to be not more than $\frac{3}{4}$ pint per hour. The weight of the complete unit is 177 lb.

(To be continued)

Modernisation of the Iron and Steel Industry

No. II *(Continued from page 9, July 4th)*

APPLEBY-FRODINGHAM STEEL COMPANY

EXTENSIONS and reconstruction schemes now in hand at the Appleby-Frodingham works, Scunthorpe, of the United Steel Companies, involve the expenditure of over £3,000,000. Their two main features are the reconstruction and electrification of the section rolling mills, and the replacement of the present Frodingham melting shop by the south melting shop now under construction. Both these schemes were approved two years ago, and it is hoped that the end of this year will see the completion of the melting shop project, and early 1948 the completion of the modernisation of the rolling mills.

A logical extension to these alterations will, later, be the shutting down of the Frodingham blast-furnaces, and the substitution for them of the new plant to be erected as extensions to the furnace plant brought into operation shortly before the war. Extension at the other end of the production cycle has already taken place, and the constructional department has a new bay erected and awaiting installation of cranes which will, when in full production, increase output by some 200 tons per week. As about half the work of this department comprises colliery material, this is a particularly valuable contribution to the national effort at the present time.

Reconstruction of the Rolling Mills.—The alterations to the rolling mill are in the nature of a major operation. The main considerations facing the designers were that the unique cooling bank with its battery of roller straightening machines has to be retained in its present position; the mill stands and roller tables of the old shop are placed too close together to permit the installation of modern equipment; and only the minimum interference with production could be permitted.

The solution to the problem has necessitated the rearrangement of the mills, so that the centre line of the mill train will be moved some fourteen yards in front of its present position and, while the finishing mill will remain on its present longitudinal axis (though the runout will, of course, be longer), the cogging mill, first roughing and second roughing mill will be placed on its opposite sides, the right, that is to say, seen from the front instead of the left. The alteration can be visualised by placing a pencil flat on the table, turning it over end for end once, and then moving it a little at right angles to its length.

The number of mill stands will remain as at present, but will be electrically driven by two Metrovick motors of 5500 h.p. and 5000 h.p. continuous rating, respectively, which will give a choice of driving the roughing stands through the cogging mill or the finishing mill. The cogging mill itself is a new one, 42in by 8ft 6in with side guard manipulators, an electrically driven bloom shears, roller tables and the necessary billet handling equipment. The existing 32in roughing and finishing mills will be moved to the new positions, new roller tables, &c., being provided where necessary. The new layout is designed to maintain output from the cogging mill at between 5000 tons and 5500 tons per week, and from the 32in mill at between 3500 tons and 4000 tons per week.

These alterations necessitate a thorough reorganisation of the rest of the plant. The engine houses for the steam driving plant are being scrapped, and a new, large electrical sub-station is being built outside the mill buildings. The ingot preheating furnace, through which pass all ingots which have to be heated from cold stock, has been reconstructed, and is in operation in an extension to the present soaking pit building, which runs across the top of the mill, between it and the Frodingham melting shop, and parallel to the latter. Two new soaking pits are being built to replace two existing pits and are so arranged as to provide scope for future developments.

The new cogging mill is to be installed on the site of the original ingot preheating furnace and could not therefore be erected until the reconstructed furnace was in operation. The first stage of the mill reorganisation can now take place, with the completion of the new building and the installation and operation of the new cogging mill. The whole of this stage can be completed without interfering with production.

The second stage, construction of new work for the roughing and finishing mills and the moving of existing equipment, will have to be dovetailed with special rolling programmes designed to cut down interference to a minimum.

The final stage, to be carried out after installation of the new lay-out, will involve the removal of the Lancashire boilers and ancillary equipment, thus providing space for future developments.

Ultimately, it is hoped to convert the mills to a lay-out having a cogging mill and a four-stand section mill.

The net result of these far-reaching alterations will be to give a new lease of life to a rolling mill that already has a long and honourable history. The new buildings will allow a better crane coverage, good lighting and ventilation; the new drives and positioning will allow more economical operation, about 1½ million cubic feet per hour of blast-furnace gas will be released for other purposes and the new soakers and reconstructed preheating furnace will also contribute to the efficiency of the mill's operation. At the same time it is intended to improve and shorten the route for ingots brought from Appleby steelworks and the new melting shop.

Melting Shop.—A corollary to these alterations to the section mill is the erection of the new south melting shop to replace the present Frodingham melting shop. By modern standards the site is restricted, access is cramped, and there is no real scope for extension. The new melting shop, therefore, is being built on a new site adjacent to the south ironworks, about ⅝mile from the section mills. The furnaces are to be fired with a mixture of coke-oven gas and blast-furnace gas made available by the electrification of the Frodingham section mills. This arrangement will eliminate the need for the producer-gas plant at Frodingham, which consumes over 800 tons per week of coal, though those furnaces now fired by producer gas at Appleby will have to continue on this supply until the blast-furnace capacity at the south ironworks is ultimately increased. Supplementary liquid fuel firing equipment is being provided at both melting shops.

At present there are two blast-furnaces at south ironworks, both blown in during 1939, 95ft high with 22ft hearths and 3000 tons per week output, to which two further furnaces will be added having 25ft hearths and 3500 tons per week output. The ore crushing plant will be adequate for the projected capacity, though the sintering plant will have to be increased by 50 per cent to produce 3000 tons per day. The present coke-oven capacity is a battery of sixty-six Kopper ovens with an output of 6000 tons per week of blast-furnace coke, which it is planned to double.

The new open hearth melting shop is to be of approximately equal capacity to the Frodingham melting shop, with an output of some 200,000 tons per year of ingots, but the steel will be melted in two large tilting furnaces instead of the four small tilting furnaces at Frodingham. The two new furnaces will be of 300 tons capacity, electrically tilted, with electrically operated door and reversing gears, the hearths being approximately 650 square feet at sill level. Hot iron will be brought from the adjacent ironworks (about 75 per cent hot metal will be used and 25 per cent of own mill scrap). There will be a 600-ton mixer with a hearth area of about 860 square feet at sill level, also electrically tilted. A portion of the stage in front of the mixer is designed to slide into ambush, to enable 60-ton hot metal transfer ladles to be lowered into the valve pit so that they can be filled while they are still suspended from the 100-ton cranes, with two of which the furnace bay is equipped. The molten mixer iron will be fed to the furnaces down removable chutes through the charging doors. There will be two 4-ton chargers of the revolving ground type.

Slag will be run off into ladles at the charging side of the furnaces. The ladles, on special carriages, will pass under the furnaces into the casting bay, drawn by the pit cranes through snatch blocks. The casting pit has two 140-ton overhead casting cranes to handle the 100-ton capacity ladles. A casting platform extends the length of the shop and there is room for four to seven heats of casting cars on which the ingots will be cast. Teeming will be done from the cranes, and from a fixed casting stand, which will have an adjustable trolley to enable two to four ingots to be cast on one car. The train of cars will be moved by an electrically operated pusher on the side of the track.

The stockyard will be equipped with two 20-ton overhead cranes fitted with magnets and equipment for lifting a tray of five charging boxes. These will be placed on stands at the back of the furnace stage from which the boxes will be picked up by charging machines.

At the same time as these extensions are in hand large central engineering workshops

are being provided. These are sited between the reconstructed rolling mills and the Appleby melting shop, and site clearance, excavations and foundation work are far enough advanced for it to seem reasonable to hope that the workshops may be completed during the first half of 1948.

Samuel Fox & Co., Ltd.

During the three years following the end of the war, Samuel Fox & Co., Ltd., will have spent well over a million pounds on plant improvements and developments. This big total is made up of a large number of items which, together, contribute to a considerable extent of modernisation and reconstruction in all departments of the works.

At the Siemens melting shop a waste heat boiler, the first of four, has been installed, as has fume extraction plant—both here and in the electric melting shop, to enable lead bearing steels to be manufactured.

Three 75-ton basic open hearth furnaces have been converted from producer gas to crude oil firing; this change was introduced to meet the difficult coal situation.

Traffic flow is being eased by the installation of lime and dolomite storage bunkers and a new overhead crane, which enables materials to be more rapidly handled to and from the stage, while in the electric melting shop a simple but effective ingot stripper has been designed and installed to deal with "stickers."

The billet mill is being equipped with an additional Priest continuous soaker furnace, with a throughput of 15 tons per hour, fired by a Morgan gas-producer plant. One furnace of this type is already installed, with a throughput of 10 tons per hour. At the same time, accuracy of temperature at the rolls is being controlled by the installation of a high speed optical recording pyrometer.

An additional Thompson water-tube boiler, for generating 25,000–30,000 lb of steam per hour, at 160 lb square inch pressure, has recently been installed, and this equipment is now being duplicated. These boilers consume low grade fuel, 75 per cent of which comes from the coal washery and 25 per cent slack.

The stainless sheet department is one of the chief beneficiaries of a new gas pipe-line from Orgreave Colliery, which at present provides some two million cubic feet weekly. It is hoped that in time this will be stepped up to about five million cubic feet.

Cold Rolling Plant.—The cold rolled strip department is being reorganised. A new shop, which has been in operation for some twelve months, is of an exceptionally light and airy construction and is finished in a colour scheme that would not look amiss in a magazine for interior decorators. In this shop, the bulk of the cold rolling plant is being concentrated leaving the old shop for the concentration of bright bar manufacturing plant, which is, at present, somewhat of a congesting factor in the wire department.

The new plant installed in the cold rolled strip department includes two Robertson four-high-speed machines, capable of operating at 1000/1500ft per minute. The output of these machines is used for high grade carbon strip to tolerances of 0·0002in, for clock and instrument mainsprings, feeler gauges and razor blades, for which there is a rapidly increasing demand.

Other mills in the department are reserved for stainless strip, for which an improved stainless strip pickling plant is being installed in an adjacent bay, originally used for galvanised strip.

The cold rolled strip plant concentrated in the new shop at Samuel Fox's works is ultimately intended to specialise on high grade strip only (25 tons per week is already manufactured here). The clock and mainspring material is a comparatively new development, initiated by a wartime demand for use in shell fuses. The manufacture of soft steel strip for tubes, box strapping, &c., is being transferred to a new works, recently acquired in Sheffield.

An interesting installation is the six hardening and tempering units now in operation for the treatment of clock and instrument mainspring material. These units each produce about 1 ton per week, and are designed for extremely accurate control of temperature to meet exacting specifications. This department is rapidly expanding and will shortly have twelve units in operation and with this capacity it is thought that all such strip formerly imported will be produced in this country.

Wire Department.—Somewhat similar plant is being installed for the treatment of wire, 6 gauge to 13 gauge, mainly for motor-car valve springs. The wire department in general is being reorganised and a number of new machines are being installed. They are of multi and single-hole types, for the production of high grade alloy steel wire, up to diameters of about ⅜in. Development is also taking place in production facilities for welding wire, which, in fact, accounts for about half the 300 tons per week output.

An entirely new cleaning plant of a somewhat novel design has been installed. The high carbon rods, after passing through a scale breaker, enter one of three acid tanks; they then pass through a specially designed and highly efficient high-pressure water spraying machine, and from there to the hot lime dip bath, which is equipped with means of keeping the lime in suspension; finally the wire is passed through an electric flash baker—the complete process of pickling, liming and baking taking some one and a half hours.

Laminated Spring Plant.—Ten years ago the laminated spring plant was converted to fully mechanical continuous line production, incorporating the latest developments of the time. A further reorganisation scheme is now in hand, involving the installation of new plant, including forced air circulation furnaces, highly specialised machine tools for machining the spring leaves, shot peening plant, aluminium sprays plant, &c. A new building is being erected to provide the necessary space for these developments, and a smaller plant is being installed to deal with the manufacture of oddment orders on continuous mechanised lines.

Sheffield Works.—Apart from these developments at its Stocksbridge works, Samuel Fox & Co. has also up-to-date schemes in the small Sheffield works they acquired from Darwins, Ltd., in 1945. Here there is an output of some 160 tons per week of strip and a small tonnage of fine wire.

This strip department, obtaining its raw material from the adjacent United Strip and Bar Mills, is producing mostly tube strip and similar qualities in widths up to 10in wide, and in thicknesses down to 0·005in. There are two Bliss four-high mills, two Bliss two-high mills, and a Robertson 10½in by 10in mill, with pickling and slitting plant.

The continuous pickling plant for descaling the hot rolled strip is of interest. It consists of an uncoiler, scale-breaking machine, acid tank, water spray, drying rolls, oiling roll and coiler, designed to process ten strips 3¼in wide or wider strips in proportion. Coils of strip are placed in an uncoiler and fed through the scale breaking rolls into the acid tank. This tank measures 90ft by 4ft and contains a 10 per cent solution of sulphuric acid. Above and below the strip line are electrodes controlled by six transformers. The acid liquor is thus heated to the desired temperature and the electrolytic action greatly assists the descaling process.

(To be continued)

A Mechanised Forge

THE new forge of Daniel Doncaster and Sons, Ltd., Sheffield, is an interesting example of the progression of special steels from stock-yard to finished forging, based on the use of mechanised equipment. Daniel Doncaster and Sons, Ltd., was established in 1778 and continues an uninterrupted family tradition. The work of the firm is concerned with hammer forging all classes of steel, especially alloy steels, the production of drop forgings and valve forgings, and of hardened steel rolls for cold rolling operations.

The new forge was laid down on vacant land adjacent to the main works; the objective in planning the layout was the provision of up-to-date methods of control for satisfactory forging manipulation under a steam hammer of high-grade steel ingots, and improving the working conditions of the men to minimise the effects of fatigue. Materials worked are tool steels of the semi-high-speed type, such as those used for hot dies, high-speed steels for cutting tools, and highly alloyed steels of the stainless and austenitic types.

The chief features of the design of the forge lie in the provision of unusually spacious buildings, in the design of the hammer foundation, and in the design of the furnaces. A mobile manipulator undertakes all furnace charging, the turning of ingots, and the manipulation of the ingots under the hammer. The hammer team is thereby not only isolated from furnace radiation, but relieved of much physical exertion at the hammer itself.

Buildings

In the provision of suitable buildings for housing the equipment, special precautions were taken to obtain comfort. For the building housing a 4-ton steam hammer glazing was provided in such a manner that the building received the full benefit of natural daylight without the discomforts of having direct sunlight. Suitably disposed around the building at a level relative to the working position of the forgemen are vertical swivelling shutters which offer ventilation and give the forgemen a view beyond their immediate surroundings thus reducing the impression of working within an enclosure.

The furnace building, which adjoins the hammer building, also came in for special attention in design. The gable of the furnace building gives a minimum working clearance in height, with the effect of trapping fumes emitted from the furnace and preventing their admission into the forge building proper. A continuous ventilator is arranged in this building and is effective in clearing hot air.

Integral with the furnace building, a lean-to is arranged for the purpose of housing the combustion chambers and fuel bunkers serving the ingot reheating furnace. Through the roof of the lean-to are openings with sliding covers, which can be opened or closed by a small winch. Each opening corresponds with a solid fuel bunker having a capacity of approximately 4 tons of screened coal. The bunkers are charged by means of a travelling jib crane which also handles material from the stock-yard to the forge running on lines parallel to the lean-to. By means of a grab, coal can be picked up from a storage pit and discharged directly into the fuel bunker through the roof openings. Sliding doors are disposed along the side of the lean-to to give ventilation around the furnace combustion chambers.

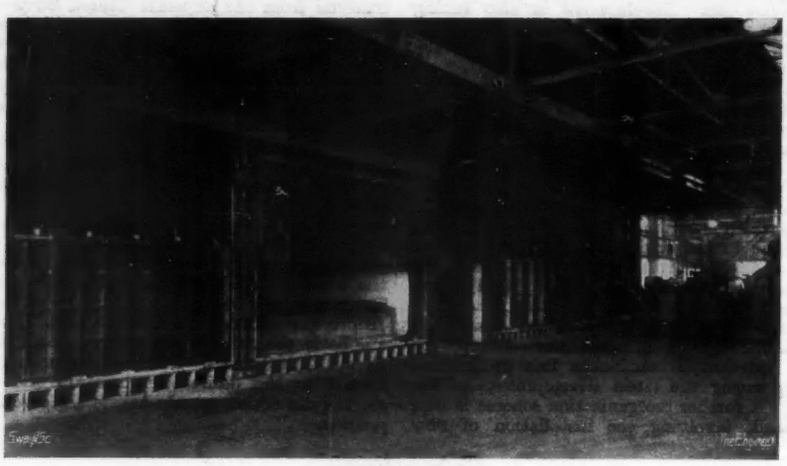
Furnaces

To achieve continuous forging production one of the many problems was the development of a furnace of suitable characteristics for the controlled heating of different steels at a definite tonnage rate per hour. The complexity of the problem was increased by the wide variation in the dimensions of the ingots to be handled.

A continuous furnace is a good medium for efficient and economical heating of ingots of uniform size and quality, but it is unsuitable for simultaneously heating ingots of differing qualities and varying dimensions. On the other hand, batch furnaces are suitable for heating ingots of diverse dimensions and

qualities, but are inefficient when used for alloy steels which have to be gradually raised from cold, through successive critical temperatures, to the final forging heat.

After reviewing the advantages and disadvantages of different furnaces it was clear that a new type of furnace, capable of operating on the continuous principle but with the adaptability of a batch furnace, was needed. Study of the metallurgical requirements in relation to the variety of steels to be heated indicated a definite need for zonal control of the furnace throughout the ranges of temperature for initial preheating up to 600 deg. Cent.; secondary preheating and soaking from 600 deg.



FURNACE INSTALLATION AND MOBILE MANIPULATOR

to 1000 deg. Cent.; and final heating for forging from 1000 deg. to 1250 deg. Cent.

It was clear, however, that the dimensions of the separate zones would need careful computation in relation to both the fixed production requirements and the different rates of thermal transfer in each chamber. Furthermore, as mechanical charging and withdrawal of the ingots was essential, the furnace had to be carefully designed in relation to the dimensions and characteristics of the manipulator. A stoker-fired quintuple-chamber furnace was ultimately installed.

Characteristics of Furnace

The furnace consists of two primary preheating chambers, one secondary preheating chamber and two tertiary heating chambers. All the chambers are in line with the forge, as shown in an accompanying engraving, to achieve continuity in the flow of heated material from the ingot stock-yard to the hammer. The primary preheating chambers are combined, but can be independently or simultaneously operated. They are of the semi-muffle type with hearths of heat-resisting steel, each 15ft wide by 7ft 2in deep. Both chambers are used for the controlled preheating of steels between 0 deg. and 600 deg. Cent.

The remaining three chambers form a separate unit. The secondary preheating chamber is of the inflame type for the controlled heating of steels between 600 deg. and 1000 deg. Cent. It is 10ft 9in wide by 7ft 2in deep. The tertiary heating chambers are also of the inflame type with hearths 6ft 6in wide by 7ft 2in deep. Both are employed for the controlled heating or reheating of steels between 1000 deg. and 1250 deg. Cent.

The complete installation occupies a site approximately 101ft long by 22ft 6in wide. The secondary preheating chamber and the tertiary heating chambers operate independently and have separate mechanical "Unicalor" underfeed stokers. In each case isolated draught control is provided to ensure simple regulation of the pressure and flow conditions.

Products of combustion from the three chambers are subsequently collected in a mixing flue and this waste heat is utilised in one or other of the primary preheating chambers for the under-heating of the steel hearth. If desired, however, the waste heat can be simultaneously used under both hearths or short-circuited to the stack.

A single "Unicalor" mechanical stoker is separately fitted to combined primary preheating chambers for top firing either or both, but in case of need, hot gases can be by-passed from the stoker to the flues below the hearth plates to implement the bottom heat. Waste heat from the high temperature chambers together with the supplementary heat from the mechanical stoker can be mixed, isolated or by-passed in any desired manner, thus ensuring complete control of the temperature conditions in the critical range between 0 deg. to 600 deg. Cent.

Each of the four underfeed stokers is capable of feeding up to 350 lb of coal per hour, but the feed to the worm can be varied in each machine by five different steps. The retorts are of the variety with surrounding grates, with air supply from the stoker fan partly to the tuyeres and partly to the grate. The design with surrounding grate provides a large area over which combustion takes place and gives rapid and complete burning of the carbonaceous residue, whilst the ash and clinker can be removed without difficulty from the air-cooled surfaces on which they are deposited.

Method of Operation

Ingots are charged by the manipulator into either of the primary preheating chambers which operate in regular sequence. Whilst the ingots in one chamber are gradually being heated from 0 deg. to 600 deg. Cent. the others in the second chamber have reached and are being maintained at the desired initial temperature of preheat. The alternate cycles are adjustable in relation to the production requirements, but by the time all the heated ingots have been separately transferred at regular intervals of time from one primary preheating chamber to the secondary preheating chamber the others in the second primary chamber are ready for withdrawal.

In this manner the secondary preheating chamber which heats the steel from 600 deg. to 1000 deg. Cent. is fed at the optimum rate by the manipulator. The sequence of flow is similarly maintained between the secondary preheating chamber and the tertiary heating chambers. Upon the attainment of the desired maximum temperature each ingot is transferred by the manipulator to the hammer for the forging process. Semi-forged products which need reheating are subsequently brought back to temperature in one of the tertiary heating chambers. Continuity of flow from the ingot stock-yard to the finishing bay is consequently achieved and maintained.

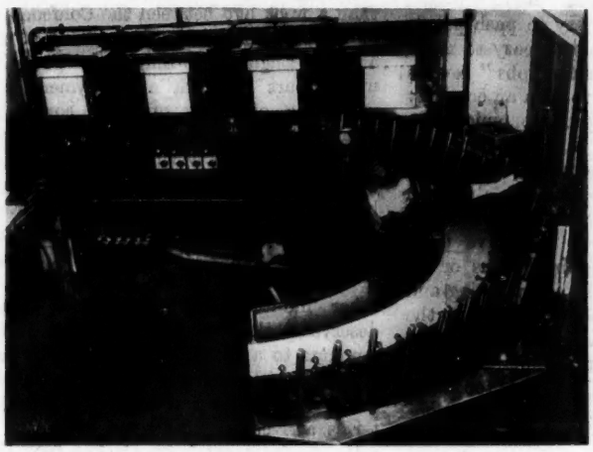
Furnace Design

Continuity of heating with zonal control and maximum utilisation of the liberated heat energy were the main objectives in the development of the furnace. One of the many problems of design arose, however, from the need to maintain unbroken draught at every chamber whenever the doors of one or another were opened for the charging or withdrawal of ingots. The low exit temperature of the waste gases and the frictional resistances of the system necessitated the installation of an injector venturi stack with an external electrically operated air-blowing fan for the creation of the draught.

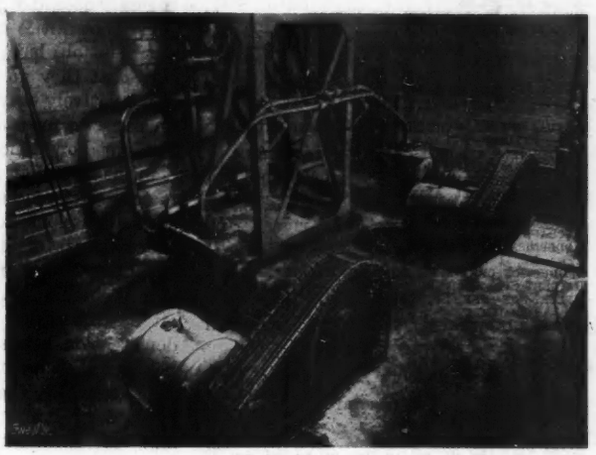
Another problem arose from the characteristics of the manipulator. The lift of the furnace doors had to be adequate to accommodate the manipulator head and to allow for the raising and lowering of each ingot; hence consideration had to be given to the loss of radiant heat during charging and withdrawal. This was minimised by equipping the five

INGOT STOCKYARD AND VENTURI STACK

chambers with sectional interlocking doors. The opening of one section to the requisite height permits the entry of the manipulator and limits the emission of heat. The interlocking sections have separate oil-hydraulic lifting cylinders and are operated from a central control room, illustrated herewith. The furnace equipment was designed and installed by G. F. Wincott, Ltd., Sheffield, in conjunction with the firm. Automatic recording pyrometric control of the furnace from atmospheric



CONTROL DESK FOR FURNACE DOORS



HYDRAULIC PUMPS FOR FURNACE DOOR OPERATION

to forging temperature is installed in the control room, shown in an accompanying engraving.

Operation of Furnace Doors

A simple hydraulically operated system is employed for raising and lowering the furnace doors. The system consists of a hydraulic power unit directly coupled through a control standard and individual control valves to the requisite hydraulic rams operating each door independently. Two separate power units are supplied, illustrated herewith, each comprising a "VSG" auto pump, fitted with internal springs for control, and driven by an electric motor with appropriate starter. Each pump is of sufficient capacity to operate four doors simultaneously, the other acting as standby.

The automatic control of the pump ensures that the doors remain in the open position whilst their respective control handles are in the forward position and in reverse the doors are automatically arrested before reaching the closed position, by a throttling device on the hydraulic cylinders.

The operator is thus relieved of the necessity of exercising care in controlling the speeds of lifting and lowering and can deal with the individual furnaces as soon as the "open" or "close" signals are given. The hydraulic installation is by Vickers-Armstrong Ltd., of Newcastle.

Mobile Forging Manipulator

A feature of the forge equipment is the 4000-lb Wellman manipulator which handles the ingots both at the furnace and at the hammer. It is believed that this machine is the first British machine of its kind to be put to work in forging practice. Its use effects considerable economy in man-power and facilitates production, whilst greatly relieving the forgemen of heavy manual work.

The manipulator is mobile and capable of operating in relatively limited working space, and is operated solely by the driver. Instructions to the driver are given over a telephone system from the control room. Control is such that precise and rapid adjustments can be made to the horizontal height, and the workpiece rotated continuously as required.

Electric power is furnished to the manipulator by a flexible cable connected to an overhead cable drum mounted on a trolley-way running the full length of the shop, and allowing the machine to operate with a 30ft range from the trolley track. The main driving motor is used to operate the hydraulic pump for those motions which are effected hydraulically and also the electric generator of the travel motion.

Twin electric motors drive the rear castor wheels, avoiding the need for a mechanical differential. Control of the travelling motion is provided by means of a reversible drum controller and foot-operated Lockheed hydraulic front wheel brakes.

Steering of the castor wheels is by two hydraulic cylinders controlled by handwheel and follow-up valve. The machine can turn in a minimum radius of 12ft when the castor wheels are rotated through 90 deg. from the straight-ahead position.

The hydraulically operated and easily interchangeable grips, which are of a particularly robust construction, are capable of holding and maintaining a workpiece up to 4000 lb in weight and 6ft 6in in length. These grips are continuously rotatable by means of a hydraulic motor, the rotational mechanism being amply protected against shock to prevent damage to the manipulator should the workpiece be out of square with the hammer during forging.

Lowering and raising of the workpiece (hoisting motion) is done by hydraulic cylinders, the arrangement of link gear being such that the grips and workpiece always remain in a true horizontal plane irrespective of the operating height.

The operating speeds of the various motions for normal working are as follows :—

Travelling	264ft per minute
Grip rotation	12 r.p.m.
Hoist raising and lowering	15ft per minute
Gripping	Full range 8 seconds

The hydraulic operating pressure is 450/750 lb per square inch.

In a machine of this type, primary consideration must be given to protection from hammer shock. For this purpose the machine is equipped with dual-purpose oil/air shock recuperators, fully protecting the parallel hoisting motion and ensuring positive gripping at the instant of impact. A self-adjusting mechanism compensates for the elongation of the workpiece during forging.

The manipulator was designed and constructed by the Wellman Smith Owen Engineering Corporation, Ltd., London.

MOBILE MANIPULATOR WITHDRAWING INGOT FROM FURNACE

Institute of Physics.—The annual report of the Institute of Physics for 1946 shows that the membership increased during the year by 299 to a total of 2830, and that there are now five branches in this country and overseas and five specialised subject groups. At the annual general meeting held on June 11th, Professor A. M. Tyndall was elected President and Mr. D. A. Oliver Vice-President.

THE ENGINEER

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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ENGINEERS, PRODUCTIVITY AND IMPORTS

IT was hardly to be expected that the debate upon Productivity of Labour in the House of Commons last week should bring forth much that was new. For the subject has been one so constantly under discussion since the war ended that almost everything that can be said has been expressed already. Only as circumstances change do the facts and figures upon which opinions are hung alter. Yet it is, perhaps, a little unfortunate that productivity should have been a subject for discussion before instead of after last Tuesday's great debate upon the import programme. As we go to press full reports of that memorable debate have only just become available and time has not yet been sufficient properly to digest the facts and figures quoted. Yet Mr. Morrison's remarks that "Unless other means are found of closing the trade gap further cuts [of imports] will be inevitable" and that "We may even have to face some cuts which will reduce our economic activity greatly and so prevent the rise in production for which all are striving" indicates how savagely shortage of dollars might affect industrial conditions in this country and affect its productivity. They reinforce, too, his further comment that "every increase in production or manufacturing output adds directly or indirectly to the margin for export," and thus reduces that deficiency on our international accounts, which might become the reason for so severe a pruning of our imports.

In the earlier Productivity debate all the well-known criticisms and suggestions were again brought out. Maldistribution of labour, rightly, was blamed for the insufficiency in the production of certain materials the short supply of which hinders the manufacture of urgently needed other goods. But Mr. Isaac's reply that "it is quite easy to push people out of a job, but it is not so easy to make sure that they go into other jobs" reveals how relatively easy it is to plan an economy on paper to meet an urgent economic situation, yet how difficult it is in fact to change it in the face of an unaccommodating human factor. References were made, as always in such discussions, to the undoubted need for the removal of practices restrictive upon output, whether imposed by unions or by employers, and also to the exasperating and often Gilbertian results of pushing the demarcation between the kinds of work to be carried out by members of different unions to extremes. The desirability, too, was stressed of improving workshop conditions and of demonstrating to workers the important parts their work plays in the making of end-products, a means that served often to stimulate output during war. All such matters, it cannot be denied, have an influence upon output. But last winter's fuel crisis demonstrated that the real key to higher output and to higher productivity lies less in the removal of restrictive practices, objectionable though they are, less in the more sensible interpretation of demarcation lines, and less in encouragement and exhortation to men to work harder, than in finding means rapidly to increase supplies of electricity and more particularly of increasing the output of coal. Nor, as Mr. Morrison pointed out in Tuesday's debate, is the objective of raising the output of coal only that of supplying our own industries. We need "for our own purposes and for those of the world generally to export coal." For only through a rapid recovery in world productivity and of world trade, for which adequate supplies of fuel are an essential, can we hope within a short time to balance our trading account with the Western hemisphere.

But whatever the ultimate effects of international economic conditions may be and whether or not the output of workers here is in reality running at a rate below that ruling pre-war the job of engineers in the immediate post-war years remains clear. In the past century output per man in our industries, irrespective of whether they work as hard now as formerly, has been multiplied many times over by the improvement of machinery and of managerial and productive methods. In a period of full employment when unions may be expected to view changes with less hostility than in the past, the rate of that improvement is limited only by the ingenuity of engineers, by the conservatism of the working man, which can the more easily be overcome if new machines and methods lead to improved working conditions, and by the economic circumstance that new machinery must, by economising manpower, more than compensate for the increased "overheads" that it imposes on the works. However doubtful the economic outlook may become, it still remains to-day the main task of engineers to multiply output by the invention and development of such improved machines and methods. That must be their contribution to the solution of this country's and the world's economic troubles.

STAGGERED HOURS

AN Agreement was announced rather more than a week ago between the Confederation of Shipbuilding and Engineering Unions and the Engineering Employers' Federation upon hours of work and payment when staggering of hours of work comes into operation next autumn to relieve the peak loading upon electricity generating stations. That Agreement is all the more welcome because at previous meetings the differences separating the two bodies seemed almost insurmountable. It will no doubt act as a model upon which similar agreements for other industries will be based. Yet it deserves notice that the Agreement, in fact, amounts to a compromise not wholly satisfactory to either party. We do not therefore feel it desirable to comment upon or criticize terms arrived at with some difficulty, but rather to draw certain conclusions from them and from other remarks included in the Agreement drawn up by the parties.

It will have been noticed from the full details of the Agreement published in our last issue that for a normal length of working day any hours worked between 7 a.m. and 8 p.m. are to be regarded as normal hours, and that in making up the forty-four-hour week Saturday morning may, if necessary, be included. These provisions amount to a considerable concession from the trade union side. There is, of course, envisaged by such terms the working, whether in a single factory or by joint arrangement over a whole area of many factories with staggered hours, of two shifts per day. But a little calculation shows that if the shifts are to be of normal length some overtime will need to be paid in each thus requiring from employers some increase of rates of pay. Further, it will be seen that the Agreement covers in reality only the principles that shall rule regarding payment for hours worked. It is left to Regional Boards in the various areas to arrange the actual staggering of hours in the various factories and shops concerned. Nor is this detailed work by the Boards likely to prove simple. It is, no doubt, true that there is ample electricity generating capacity in this country to meet all demands, providing the load can be sufficiently spread. But, as a glance at a typical diagram of winter weekday loading of the electricity system will show, a spreading of the load over the hours between 7 a.m. and 8 p.m. is wholly insufficient to prevent load-shedding. Moreover, allowing for the effect of the domestic load which inevitably reaches its peak during a part of the day and evening hours even a spreading of the industrial load over the hours between 5 a.m. and 10 p.m., thus permitting a double day shift, would still prove insufficient wholly to prevent load-shedding. Some part of the load will need to be transferred to the night and more particularly to those "small" hours when

the load normally falls to its minimum. It may, too, prove necessary to have recourse to week-end working. Nor is it safe in making such calculations to assume that the total load to be carried will amount to no more than that carried last January. For if this country's industries are to have recovered from the fuel crisis to the extent expected by the Government and are able by midwinter to provide the planned increase of exports and more ample supplies for the home market, the demand for power will necessarily be substantially increased. Nor is that increase in the demand at all likely to be completely counterbalanced by the coming into operation of new generating capacity.

Clearly the task of Regional Boards in co-ordinating arrangements for staggered hours of work in their respective areas is one of no mean difficulty. But it will, we think, be rendered no easier by the statement in the Agreement that "It is essential that there should be 'equality of sacrifice' between firms, districts and industries according to their various circumstances . . ." How tired we grow of this insistence, wherever there is sacrifice, as there is to-day wherever there is rationing or control, that it must be equal! For, in truth, in times of stress and under abnormal conditions sacrifice can no more be equal industrially in peace than it can amongst the soldiers of an army in war. Indeed, the very principle of equality is in itself a negation of that unselfish team spirit that refrains from counting personal cost so long as the job to be done is done. Can every firm in a district, despite the wide variety of operational needs, expect to have its sacrifice precisely calculated by the Regional Board? Must one district better supplied with generating capacity work inconvenient hours lest it sacrifice less than another in which capacity is less ample? Can smaller firms adapt themselves to double-shift working as easily as larger ones? Can the discomfort of domestic consumers deprived of heat and light really be weighed precisely in a balance of sacrifice against industrial losses due to inconvenient hours or load-shedding? It is only necessary to ask such questions to see how impossible it is to measure sacrifice. Moreover, if the principle of equality is too much insisted upon may not efficiency itself be sacrificed? What equality was there during the war when the peacetime work of several competing factories was concentrated into one and the remainder turned over wholly to war production? How else except by such inequality could provision be made for the efficient manufacture of a reduced output of peacetime goods? Equality of sacrifice, if indeed it is attainable at all, should, we believe, be demanded only if it can be shown not to prejudice the carrying out of whatever work lies to hand. Least of all should it be regarded as a first essential.

Literature

SHORT NOTICES

Electronics in Industry. By George M. Chute. New York: McGraw-Hill Book Company, Inc. Price 5 dollars.—The declared aim of this book is to present a broad introduction to the use of electronic circuits and equipment in industry. Intended generally for the industrial user, the book is of little interest to those who are concerned with the design or manufacture of electronic apparatus. Avoiding the orderly classification found in many text-books, the author aims at maintaining the reader's interest by a progressive treatment of the subject. The text is based on an evening study course in industrial electronics as taught by the author to Detroit students who worked in factories and wished to acquire a general knowledge of electronics which would help them to understand and service the equipment installed. Apart from the use of simple arithmetic in worked examples, the book is non-mathematical. Thermionic valves are explained from first principles, and the use of valves in electronic equipment, progressing from simple to more complex circuits, is lucidly described in a manner that should appeal especially to the reader whose previous knowledge of electronics is slight.

The Vector Operator j. By F. C. Gill, A.M.I.E.E., A.I.Mech.E. London: Sir Isaac Pitman and Sons, Ltd., Price 7s. 6d. net.—This book of 61 pages is devoted to the subject of simplifying certain calculations by explaining, with the help of a large number of worked examples, how the vector operator j can be readily applied to the numerical solution of electrical problems. After explaining the method, the author shows how it can be used to evaluate electrical quantities in single-phase series and parallel circuits, in two-phase, three-wire systems, and in three-phase systems. The book should appeal to those electrical engineers who are content to learn how to apply this useful mathematical tool to practical problems without becoming involved in purely academic considerations. Nevertheless, the serious student may find his appetite for further study whetted after reading the final chapter, which summarises the various mathematical forms in which a vector can be represented.

History of Air Navigation. By Arthur J. Hughes, O.B.E. London: Allen and Unwin, Ltd. 10s. 6d.—The author of this useful and interesting book has completed fifty years as a maker of marine and aircraft navigation instruments, and his firm, Henry Hughes and Sons, Ltd., goes back for more than 150 years. He is therefore well qualified to write authoritatively on the subject. The book is an interesting and readable account of the development of air navigation. The seaman took 500 years to perfect his navigation; the airman has taken 33 years, ten of them years of actual warfare. The record of these years is one of intense activity and constant change. Accounts of famous flights are given to illustrate the steps by which air navigation has grown to be an accurate and useful science, and the future of air navigation is outlined in later chapters. Throughout there are well-reproduced illustrations, both in the text and as plates.

BOOKS RECEIVED

Aircraft Strength of Materials. By H. D. Conway. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 21s.

A Planned Auxiliary Language. By H. Jacob. London: Dennis Dobson, Ltd., 29, Great Queen Street, Kingsway, W.C.2. Price 10s. 6d.

British Petroleum Equipment. London: Council of British Manufacturers of Petroleum Equipment, 40, Palace Chambers, Bridge Street, S.W.1. 10s. 6d.

Examples in Engineering Drawing and Design. Vol. III. By H. Binns. London: Hodder and Stoughton, Ltd., Warwick Square, E.C.4. Price 6s.

International Air Transport. Third edition. London: Todd Reference Books, Ltd., 49, Park Lane, W.1. Price 25s.

Modern Electrical Engineering Mathematics. By S. Austen Stigant. London: Hutchinson Publishing Company, Ltd., 47, Princes Gate, S.W.7. Price 31s. 6d.

The Escalator Method in Engineering Vibration Problems. By Joseph Morris. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 21s.

Metal Working and Heat Treatment Manual. Vol. 2. By F. Johnson. London: Paul Elek (Publishers), Ltd., Diamond House, 36–38, Hatton Garden, E.C.1. Price 17s. 6d.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SCIENCE, LIBERTY AND PEACE

SIR,—Without wishing to involve myself in a philosophical, religious or any other kind of dispute, may I question the alleged facts forming the basis of your recent editorial criticism of Aldous Huxley's "Science, Liberty and Peace"?

Your contention that applied science's "little bit of temporary harm, . . . little short-lived inconvenience, but adding always in the end to those things that meet mankind's bodily needs or increase his pleasure and contentment. Were it not otherwise . . . it would not have been tolerated," calls for the following comments.

The mass application of applied science dates back little more than 150 years. For 100 of these years those human beings unfortunate enough to become the victims of industrialisation suffered wretchedly sub-human lives in its factories and towns. During the same period it transformed the country from a self-supporting, 90 per cent agrarian economy to a predominantly industrial one, and created the environment conducive to a vast increase in population.

The figures speak for themselves. In the year 1700 the population of England and Wales was 6,122,000; in 1800 it was 8,900,000. During the next hundred years of the Industrial Revolution the population had trebled, until by 1900 the total was 29,000,000. This increase continually accelerated until 1941 when the figure was 42,000,000. To-day in consequence of this phenomenal increase in population we find ourselves almost entirely dependent upon our overseas trade for the essentials of existence, and incur in increasing measure all the hazards entailed in the necessity for protecting and exploiting our trading interests abroad. This is an historic fact which few people to-day can regard with equanimity.

The facts of our world situation are now so grim that one can only marvel at the facile optimism displayed by the propagandists of eternal progress. Because from the outset the uses to which applied science have been put have been private profit and its ancillary military science, the material benefits of which you speak were only indirectly the reward of the toiling populace whose physical and spiritual interests were disregarded.

To-day it is generally realised that a materially wealthy populace is good for business and that industry and civilisation functions mainly to satisfy this market. This it does, however, not because it underwent a fundamental change, but because the system it perpetrated and which can only exist on its absorption of ever-widening markets, has now indirectly to increase the material wellbeing, first of its workers and eventually of the industrially undeveloped coloured peoples, as the only means to its survival.

In the factories we have seen the introduction of a more humane pseudo-psychology because it is conducive to higher production. Thus have we become gripped in a system which, disregarding the real psychological, physical and spiritual needs of man, uses him remorselessly for two-thirds of his waking life in order to satisfy its insatiable appetite for increased production, and encourages him to indulge in those pursuits of leisure which are also good business propositions.

Well, whatever else centralised industry achieves, it cannot continue to condition a man by remote control to a meaningless occupation, and expect him to take pride in his calling, to develop a keen sense of individual responsi-

bility, and to become a firm advocate of democratic ideals; but then, under these industrial conditions, do we desire these qualities? The democratic and Christian ideal of man is, of course, anachronistic in our present society, but few of the advocates of mechanical progress will publicly admit the fact.

Our modern environment may or may not be inimical to man's "contentment." Certainly, nervous diseases are now more prevalent than ever before, and the latest statistics from the U.S.A. on this type of disease provide conclusive evidence of the ravages of industrialism upon the mind of man. But, then, if one is to use your argument as proof of the inherent "naturalness" of our industrial civilisation, which is barely 150 years old and already confronted with self-destruction, one might just as well argue that slavery is more conducive to man's "contentment" because it was tolerated for a thousand years.

Common observations to-day would seem to indicate that centralisation of power, with its attendant evils of governmental, industrial, trade union and Press bureaucracy, is contributing very little to our every-day "contentment." Between them they have made the day not far distant when all centralised units will be concentrated in one source, and that in order to cope with our economic plight we shall be forced to direct men where and when they are required. If and when that day dawns, it will be the final link in a chain of events forged with the good intentions of applied science, painted with the assurances of its apologists, and ultimately disintegrated by an atomic bomb.

What, then, is the alternative? The alternative for those who desire it is complex and tentative, and has received its fullest exposition in Huxley's "Ends and Means." I can do no more than commend it to you.

G. A. Felton.

London, W.11, July 1st.

DIESEL LOCOMOTIVES

Sir,—A comparison of the specific weights of various types of diesel-electric locomotives, based upon the nominal brake horsepower of the diesel engines themselves, is of little value unless one can be certain that the horsepower ratings have all been established upon the same basis. The General Motors Class F-3 unit, referred to by Mr. Brian Reed in your issue of May 9th, is indeed one of the lightest per engine horsepower of recent large diesels, but it should be carefully noted that the tractive-force-speed diagrams prepared by the manufacturers, who are not in the least likely to underestimate the probable power of their product, show that only 74 per cent of the "installed engine brake horsepower" listed by Mr. Reed is available at the treads of the driving wheels throughout the normal range of operating speeds. The percentage for the Ingalls locomotive is slightly lower. In recent ALCO, Baldwin and Fairbanks-Morse locomotives, the manufacturers' tractive-force-speed charts indicate that from 80 to 85 per cent of the nominal brake horsepower of the diesel engines is available for tractive purposes.

Since these several designs do not differ radically in general arrangement, it is probable that the percentage of power absorbed by auxiliaries and the losses inherent in electric drive are much the same in all of them. Certainly, the differences do not justify the assumption of a 26 per cent loss in power between the diesel engine shaft and the rail in one case, and only 15 per cent in another. One is therefore forced to the conclusion that the manufacturers have not yet reached a standard basis for the maximum brake horsepower rating of their diesel engines.

The diesel-electric locomotive is definitely regarded by many American railways as the locomotive of the future, and is being promoted vigorously by the locomotive builders, but there is still room for considerable improvement in some directions. First and foremost, the initial cost, which is still around 90 dollars per nominal engine brake horsepower in large diesels, is too high. Some improvement in this figure could be obtained by a reduction in specific weight per horsepower. The best of the present diesel-electrics are scarcely equal to the most efficient modern steam locomotives in maximum horsepower delivered at the drawbar per pound of total locomotive weight. Secondly, the cost of repairing diesel-electric locomotives has shown a tendency to increase rather rapidly with the age of the locomotive, exactly as had been predicted by those familiar with steam locomotive repair costs. In a paper presented to the American Society of Mechanical Engineers last December, the chief mechanical officer of one of our largest Western railways listed twenty-six major and minor alterations which he considered necessary in both existing and future diesel-electric locomotives in order to reduce maintenance costs to a more satisfactory level.

Wm. T. Hoecker.

Galveston, Texas, July 5th.

HUMAN RELATIONSHIPS IN INDUSTRY

Sir,—I cannot agree that this problem is "intangible," though it is certainly not easy to handle. But Mr. Rice, in his article of June 20th, starts on sound lines, and then goes off the rails.

A straightforward organisation certainly lends itself to a chart, which is common form, but to human relationships in a sort of card-index classification tends towards the present-day heresy of substituting clerical control by paper records for skilled control by personal contact. There is no reason at all for personal contact to be weakened in the largest organisation if certain basic principles are observed; of which the most important are:—

(1) A clear chain of responsibility from the chargehand with a small squad of men, through the foreman and departmental managers, right up to the top.

(2) No one man to be in direct charge of more subordinates than he can keep in close touch with.

(3) No cutting of the chain by the introduction of roving controllers, who merely put the responsible man out of his stride (a widespread evil at present).

(4) A full delegation of authority with responsibility. It is a common fault of human nature to try passing on responsibility whilst retaining authority and it cannot be done.

The card-index expert and keeper of records will always try to be boss; he is a very useful person in his proper place. Finally, the way to get the individual to do his best is to make it worth his while.

F. L. Watson.

Lyndhurst, July 4th.

Sir,—I read with much interest the article on "A Study of Relationship in Industry," by Messrs. Gillespie and Rice, appearing in your issue of June 20th.

It seems to me to afford an illustration of a modern tendency, which is perhaps even stronger across the Atlantic than it is here to try to work everything to a cut-and-dried system. This tendency almost always ignores certain imponderable factors which in most cases are far more fundamental than those points which can be taken care of by the system.

A chart such as is suggested in the article and illustrated in Fig. 2 would without question be very valuable since the analysis at the bottom affords a good reflection of the efficiency of a firm from the personal angle. If instead of the conventional signs used to indicate the personal relationships, numbers were substituted—"0" corresponding to "bad" and, say, "6" to friendly relations—a general average of all the relationship numbers would indicate the personal efficiency of the whole firm, whilst the average figure for each individual would give the measure of his personal efficiency.

The difficulty as I see it arises in drawing up a chart. My experience leads me to say that no employee would express his unbiased opinion of his colleagues officially to any member of the staff, except in an organisation where complete confidence had been established between all its members, in which case the chart would be superfluous.

The only way of establishing the mutual confidence that is so desirable is through the personality of the head of the organisation—the managing director in the case of an industrial company.

The authors' chart, therefore, would be helpful to a managing director who lacked the personal qualities to establish such confidence, but there are no means by which he could obtain one on which any reliance could be placed. For the man who has established the requisite degree of confidence among his staff and colleagues it is unnecessary.

W. A. Green.

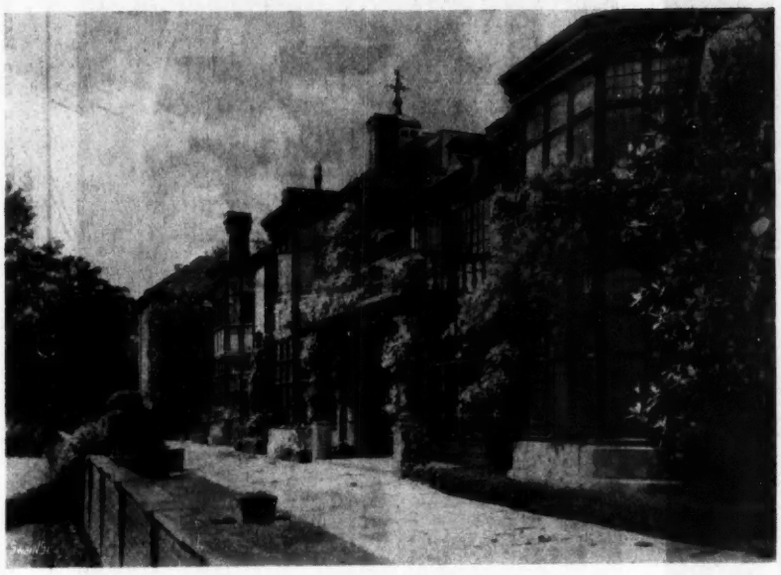
Virginia Water, July 3rd.

Report on the Southern Railway Byfleet Derailment

The Report to the Minister of Transport into the causes of the derailment which occurred about 4.31 p.m. on Friday, December 27th, at Byfleet, on the Western Section of the main line of the Southern Railway has now been issued by the Stationery Office. It was compiled by Colonel A. C. Trench, who was assisted by Brigadier C. A. Langley. It will be recalled that the 2.20 p.m. train from Bournemouth to Waterloo, travelling on the up through line under clear signals at about 60 m.p.h., was completely derailed, the engine coming to rest near the west end platform of Byfleet station. Only three passengers received injuries. The train consisted of twelve bogie coaches, of which the leading six had Buckeye couplings. Their total weight was 394 tons, and the vacuum brake was in operation on all wheels. The train was drawn by engine No. 851, "Sir Francis Drake," of the "Lord Nelson" four-cylinder class, type 4–6–0, with an eight-wheeled tender, the total weight of the engine and tender being in working order about 143 tons. The subsequent examination of the locomotive did not reveal any signs of defect which might have caused or contributed to the derailment. On the contrary, it was recently out of the shops, and was apparently in first-class condition. The permanent way, as measured subsequently, did, however, indicate defects of a magnitude quite sufficient to have caused the derailment. In the opinion of Colonel Trench, based on his own experience of the ground in the immediate vicinity, the layer of hard sand and clay existing under the track might in some places tend to form pockets of water after heavy rain or snow, and give a tendency for these to remain as soft spots for some time before draining away. The rolling and hammer blows, present with the normal passing of the "King Arthur" engine of the previous train, only five minutes earlier, might have resulted in the sudden development of abnormal irregularities of cross-level in the rails. Colonel Trench concludes that the responsibility for this derailment must be attributed to inadequate appreciation by the permanent way staff of the difficulty of satisfactory maintenance of the track in this cutting, under exceptionally severe conditions.

Fulmer Research Institute

ON Wednesday, July 2nd, the Fulmer Research Institute Ltd., near Slough, was officially opened by Sir Stafford Cripps, the President of the Board of Trade. A large company of friends and guests were present. The Institute has been founded in order to provide a research centre where firms can use first-class facilities, backed by the services of a team of scientists of wide knowledge and experience. The results of the research work remain the sole property of the firm. So far the scope of the Institute has been confined mainly to the metallurgical field, but it may be later expanded in other directions.



MAIN BUILDING

It does not compete with any other research centre in Great Britain, and it is hoped that it will fill a long-felt need, and will play a part in this country comparable with that played in American industry by the Battelle, Mellon and other American research institutes.

The directors of the Fulmer Research Institute are Colonel W. C. Devereux, F.R.Ae.S., chairman; Mr. Nigel Balchin; Mr. E. A. G. Liddiard, M.A., F.I.M.; Mr. W. R. Merton; Mr. Spence Sanders, and Mr. H. G. Warrington. The staff includes forty members working under the following senior officers: director of research, Mr. E. A. G. Liddiard, M.A., F.I.M.; principal scientist, Dr. P. Gross, Phil. D.; principal physicist, Mr. H. Sully, M.Sc.; metallurgists, Mr. E. A. Brandes, B.Sc., A.R.C.S., Dr. H. K. Hardy, M.Sc., A.R.C.M., Ph.D., and Mr. C. S. Campbell, M.A.; physical chemist, Mr. D. L. Levi, M.A., B.Sc.; engineer, Mr. E. W. W. Double, B.Sc., A.I.M.M.E., and librarian, Miss S. P. Foster, A.L.A.

In introducing Sir Stafford Cripps, Col. W. C. Devereux outlined in brief the background of the new venture, which he said had its real birth two years ago, when he was forming a new group of companies and the question of finding and providing research facilities for them had to be considered. Sir Stafford, he went on to say, had taken a kindly interest in the scheme right from the beginning and had given it every support and encouragement throughout its development.

Sir Stafford outlined the various research methods such as those operated by the D.S.I.R., the Universities, Government and private bodies, upon which British industry depended, he said, for its vitality and progress. Amongst these organisations there were a number of gaps, the principal of which was in the range of the smaller but enterprising firms which could not of themselves afford to set up research departments proportionate to their vigour. The Fulmer Research Institute was particularly designed to fill part of that gap, and it was the prototype of the kind of research organisation which would largely fill the gap altogether. It was founded on three principles; first, that it was absolutely first rate in its staff and equipment; secondly, that the results of research sponsored by an individual firm were retained by that firm, whether in the form of "know-how" or of patents, and, thirdly, it was non-profit-making. Another convenient arrangement was that made for members of the staff of the sponsor firm to come and work in the Institute so that they would thus be in a position to translate the results back to the factory. It also economised in scientific effort, and he wished it every success.

Mr. Liddiard thanked Sir Stafford and Lady Cripps and said that the will to succeed which was inspired by the chairman, Colonel Devereux, permeated the whole of the Institute's staff, which worked as a team. The problems on which they were working, and of which more were wanted, were those involving physical metallurgy, metal purification, and distillation, the application of thermodynamics to industrial metallurgy, protection and finishing problems, and the development of new casting processes, and procedures. It was hoped to attract private firms, and to work for groups of firms or for a particular section of industry. He pointed out that the fine aluminium portable building in which tea was served had been lent by the associated firm Structural and Mechanical Development Engineers, which was responsible for its design fabrication and quick erection.

The Main Building

The main laboratories and the library, also the administrative offices, are housed in a converted Edwardian country house, while the workshops, casting and heat treatment laboratories are situated in a new building close to the original house. The accompanying engravings show the main building and an interior view of the engineering shops. The buildings stand in about ten and a half acres of ground, with five acres of orchard and garden, along with a paddock of some five and a half acres, giving ample room for future expansion.

Some 20,000 square feet of area is available in all the buildings, of which 7000 square feet are available for experimental laboratories, 1000 square feet for workshops, 2,300 square feet for laboratory storage, 2275 square feet for studies, offices, and conference room, and 525 square feet for the library. The limited area of cellerage has made it necessary to install the heavier equipment of the melting testing laboratories on the ground floor, making use of separate concrete bases at ground level for heavy or vibrating machinery, the first floor being reserved for the laboratories calling for lighter equipment. Gas mains have been laid in anticipation of a local supply and, meanwhile, use is being made of "Calor" gas fed to all essential points from individual gas cylinders. The Institute is provided with three-phase electric power at 50 cycles frequency and 415 volts line voltage, and in most laboratories 230 volts single-phase supply is also available. Direct current for corrosion tests, etching, polishing and engineering laboratories is furnished by rectifiers. Heating is by hot water from a coke-fired boiler, and good laboratory ventilation has been provided. In the new building similar power and heating facilities are installed, the heating being supplied from an oil-fired boiler.

MACHINE SHOP

The administrative offices which include the director's office and the conference room, face the main entrance; thus all administrative work is concentrated at one end of the building.

Metallographical Equipment

The metallographic and photographic sections are in the east wing, on the first floor. The largest room of the three faces south and

LABORATORIES OF THE FULMER RESEARCH INSTITUTE, STOKE POGES

SPECTROGRAPHIC LABORATORY
ENGINEERING LABORATORIES—TENSILE AND HARDNESS TESTING

METALLOGRAPHY—BAUSCH AND LOMB METALLOGRAPH
ENGINEERING LABORATORIES—FATIGUE AND IMPACT TESTING

houses the Bausch and Lomb metallograph, which we illustrate opposite. It provides for the examination and photographing of specimens at magnification from 50 to 2500, with attachments for dark field illumination and for examination by polarised light. Other apparatus we noted includes a Beck bench-type metallurgical microscope, and a Watson binocular microscope. Equipment for thermal analysis will also be housed in this laboratory. A second laboratory is arranged for polishing, mounting and etching specimens, while a third room is equipped for photographic work, with ample room for storing photographic material and negatives.

In the corrosion and plating laboratory a bench is used for electro-chemical measurements, and there are wall benches for special corrosion testing, with outside window space for atmospheric and spray corrosion testing. Apparatus under construction includes a salt spray cabinet and four-point loading stress corrosion testing apparatus. On the left-hand side is a bay for plating and anodising experiments, which has a lead-lined tray and is furnished with electric current.

Alongside this room is a general study room in which investigators can write up their reports and prepare drawings. Three other studies are provided for the senior scientific staff.

Next the study is a dark room for the development of spectrographic plates, and a small laboratory where spectrum lines are identified by a spectrum viewer, and their intensities measured by a microphotometer. The spectra are photographed in a third room facing south, which is completely screened for working with high-frequency sparking. A Hilger medium spectrograph is available (see opposite page), and electrical controls for d.c., arc and high-voltage high-frequency spark excitation are provided.

Vacuum Laboratories

Two interesting laboratories are those set aside for specialised work involving high vacua and temperatures. The first of these, facing south, is fitted with a flat-topped central fixed bench furnished with all services. Flat-topped marble benches are also available. Pumping equipment, designed to maintain a vacuum of 0.001mm of mercury, and platinum furnaces, giving temperatures up to 1500 deg. Cent., with appropriate controllers and recorders are installed. As this work involves reactions with metallic halides, fume cupboards and wall benches are provided for the preparatory and ancillary work. This work forms the basis of a process for the extraction of aluminium from comparatively dilute alluminium alloys produced by electro-thermal reduction and a process for the purification of aluminium.

Chemical Laboratories

The group of chemical laboratories on the first floor consists of a main general chemical laboratory, one laboratory set aside for colorimetric and absorptiometric work, with a small laboratory for microchemical analysis and other specialised work, along with a balance room. The main laboratory has a central bench and a wall bench with a fume cupboard and hood. One bench is set aside for glass blowing, and there is a small muffle furnace for ignitions and a thermostatically-controlled oven, together with the more general chemical apparatus. A Hilger-Spekker absorptiometer is installed. In the microchemical laboratory we noted a Tinsley polarograph, with its ancillary amplifier and recorder. The second floor contains a light chemical store and the duplicating equipment.

Material Testing and Creep Laboratories

On the ground floor are the mechanical testing and creep testing laboratories, views of which we reproduce herewith. Provision is made for testing the strength of materials at both room and elevated temperatures. The large testing machine is an Avery 10-ton single-lever machine, which is designed to carry out either tensile, bending or compression tests. There is a standard Izod impact testing machine and Vickers-Diamond and Rockwell hardness testing machines. the Rockwell machine being adapted for carrying out comparative hardness tests at high temperatures. The other view reproduced shows the 30-cwt Haigh fatigue testing machine for alternating, compressive and tensile stresses, with or without a mean tensile stress. The machine is designed to operate at 1800 reversals per minute, and it can also be modified for making tests at high temperatures. The Avery duplex Wöhler machine for reversed bending at 2000 reversals per minute with single-point loading is also shown in our illustration.

The creep-testing laboratory, which we do not illustrate, has a concrete floor on which are installed two 5-cwt Denison lever pattern creep testing machines of the National Physical Laboratory type, designed for creep tests at temperatures up to at least 1000 deg. Cent. Some new additions to this laboratory are being built in the Institute's workshop, and they include machines based upon an N.P.L. design for creep testing miniature specimens in compression up to 1200 deg. Cent. as a quick sorting test in developing creep resistant alloys.

The Physics Laboratory

The main physics laboratory is on the ground floor and it has central flat-topped benches and wall benches. It is arranged for measurements of electric and thermal conductivity, instantaneous specific heat, static and dynamic strain, and the determination of the coefficient of thermal expansion and other dilatometric work. The calibration of thermo-couples is also undertaken in this laboratory. There is a Kelvin double bridge for electrical conductivity measurements, and a strain gauge bridge with cathode ray oscillographs, together with potentiometers, Wheatstone bridges and galvanometers. Other optical, thermal and dilatometric apparatus is in course of construction in the Institute's workshops.

Leading from the main laboratory is a small lead-lined room containing a Metropolitan-Vickers crystallographic X-ray set. Room is left, however, for a more powerful X-ray set for radiographic work, should this be needed. The cameras available, include Metropolitan-Vickers 9cm and 19cm powder cameras, a universal camera, and a goniometer head for work on single crystals. There is also a Unicam high-temperature camera for carrying out high-temperature studies in the constitution of metals and alloys at temperatures up to 1000 deg. Cent. An instrument for the precise measurement of X-ray films is in course of construction.

There is a fine library on the ground floor, with, in addition to bound "Transactions" of Scientific Societies, some 400 volumes of text and reference books and numerous reprints of articles of technical interest. A kitchen and canteen is provided for the laboratory staff, accommodating forty-eight persons at one sitting.

Engineering Workshop and Foundry Building

The new building, an interior view of which we give herewith, is excellently constructed to harmonise with the main building. The room for the heating boiler also accommodates the compressor for air supply. Melting furnaces are installed in a pit at the far end of the laboratory, which is supplied with single-phase and three-phase current and compressed air. The melting furnaces include a 20kVA Electric F..rnace Company medium frequency (3000 cycles) induction furnace of the motor generator type designed for melting in special atmospheres or in vacuum. There is also a 27kVA "Silit" rod electric resistance furnace designed to melt 38 lb of aluminium. In addition, we noted a Morgan oil-fired furnace of 20 lb capacity and a tilting arc furnace suitable for precision casting. A large electrically-heated core-drying oven, which can also be utilised for low temperature heat treatment and a sand mill are installed in this laboratory.

Adjoining the foundry is the die-making and sand-testing department, with sand-testing equipment and a vibrating table for sieve shaking and consolidation for the "lost wax" type of mould used in precision casting.

Adjacent to the sand testing laboratory is a paint and enamel spraying booth, in which paint, metal and other forms of spraying are carried out.

Heat Treatment Laboratory

The north wing of the new building houses the heat treatment furnaces, which include a "Birlec" forced air circulation furnace, primarily reserved for the heat treatment of light alloys, and suited to temperatures below 700 deg. Cent. There are three other furnaces, one of which is a "Silit" rod furnace, designed for operation at temperatures up to about 1400 deg. Cent., while a gas-fired refractory kiln for temperatures up to 1800 deg. Cent. is also under construction. Space is reserved in this laboratory for the carrying out of special research work requiring small experimental plant, and for the installation of further metal working equipment.

The Engineering Workshop

The laboratory workshops, which are served by a staff of six persons are situated in the south wing, and are illustrated herewith. The equipment we saw running in the shop includes a 5in Holbrook precision lathe and four other lathes, all of which are electrically driven. There are four drilling machines for drills of 1½in down to the smallest diameter. Other machines are the hacksaw and bandsaw, and a shaping machine, universal grinder and a universal milling machine. For sheet metal work a set of bending rolls and a brazing hearth with blowpipe equipment for cutting and welding, are available. Leading from the main workshop is a small room for the construction and maintenance of laboratory instruments.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

COMPRESSED ASPHALT, ROLLED ASPHALT, AND MASTIC ASPHALT

Broadly speaking, these new editions are in the nature of a reprint of the specifications published in 1935, but they differ from them in that they incorporate a few essential alterations, some of which have been made to meet the present supply conditions and others made in the light of the experience gained during the last ten years. The essential alterations to each are as follows:—

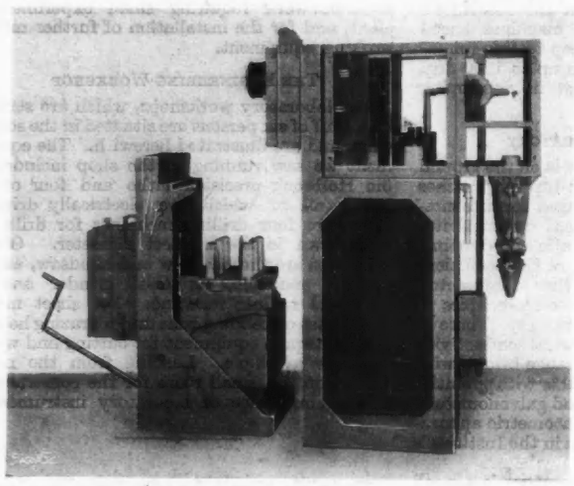
B.S. 594 : 1945. Rolled Asphalt (Hot Process). The opportunity has been taken to issue the requirements for single-course and two-course work as complete and separate specifications, as it is felt that this will tend toward greater clarity. Accordingly, B.S. 594, Part I, covers single-course rolled asphalt, and B.S. 594, Part 2, covers two-course rolled asphalt. The filler clause has been altered to include limestone as well as Portland cement. The sand grading has been altered in the light of experience and the raw material supply position. In the case of the single-coat asphalt mixtures, the maximum percentage of stone permitted in courses of varying thickness has been amended, and increased quite considerably. In both the single-course and two-course specifications the rich schedule appearing in the original edition has been omitted as experience has shown that generally speaking this is inapplicable to present-day practice. In connection with the provision of a rough surface the size of chippings is expressed as both ⅜in. and ½in., and the appropriate covering area for each is given.

B.S. 596 : 1945, Mastic Asphalt. The opportunity has been taken to issue the requirements for mastic asphalt of natural rock asphalt aggregate and mastic asphalt of limestone aggregate work as complete and separate specifications, as it is felt that this will tend toward greater clarity. Accordingly B.S. 596, Part 1, covers mastic asphalt of natural rock asphalt aggregate, and B.S. 596, Part 2, covers mastic asphalt of limestone aggregate. Greater latitude is allowed in respect of the size of the chippings which can be incorporated in the mastic before laying, otherwise the alterations made in republishing this specification are of a relatively minor character.

B.S. 348 : 1945, Compressed Natural Rock Asphalt. The amendments made apply particularly to the preparation of the surface and the application of chippings.

A Compact Distribution Switchgear Unit

AT the present advanced stage of development of distribution switchgear, designers are mainly concerned with reducing dimensions and introducing improvements to simplify maintenance, facilitate installation and promote safety. These requirements were closely studied in designing the ALA. 1 class of switchgear which was introduced recently by Crompton Parkinson, Ltd., Electra House, Victoria Embankment, London, W.C.2, after being developed and proved at the company's Chelmsford test station.



SWITCHGEAR UNIT WITH TRUCK WITHDRAWN

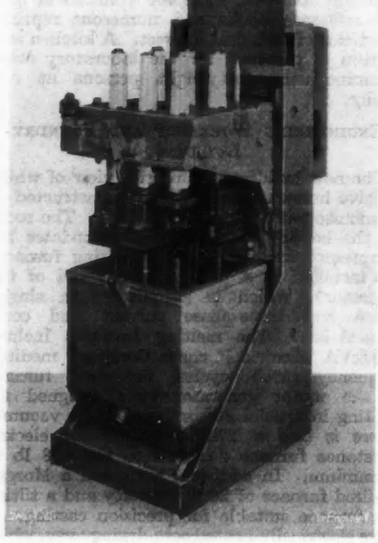
This class of switchgear is rated for service voltages of 6·6kV and 11kV, normal current 600A, and breaking capacity 150MVA but, to ensure ample thermal and mechanical factors of safety, the nominal ratings are well below the actual capacities proved by full-scale tests. The unit is completely metal-clad, embodying an oil-circuit breaker with vertical isolation and the bus bars, current transformers and connections are air insulated.

The overall dimensions of the unit—height 6ft 2in, depth 4ft 6½in, width 1ft 10½in—are the result, partly, of using a circuit breaker fitted with side-blast baffle arc control devices of the type successfully applied to other forms of Crompton switchgear for several years. In its present form, however, the switch uses a modified arrangement of contacts. The SL.100 self-aligning finger contacts, instead of engaging with a wedge-shaped moving contact, are mounted circumferentially to form a socket for a cylindrical rod contact, as shown in one of the engravings herewith. A liberal thermal capacity is obtained, partly by the general design of the contact assembly and partly because, with the SL.100 contact, the pressure increases with the current to maintain an adequate thermal capacity under any short-circuit condition.

Where contact pressure increases with current, it is essential to pay particular attention to providing a mechanism powerful enough to separate the contacts under the worst possible conditions. The opening mechanism of the ALA.1 unit is designed to give consistent operation throughout the whole range of short-circuit currents. Any form of tripping gear can be fitted. Closing can be effected by manual solenoid or spring-operated mechanism.

One of the photographs reproduced on this page shows the ALA.1 switchgear unit with the circuit-breaker truck withdrawn and the side panels removed to show the bus bar and current transformer chambers. A fabricated construction of specially designed steel sections is used for the framework, to form a rigid structure with low weight. The withdrawable truck is a completely welded structure running on roller-bearing wheels, which are adjustable to ensure smooth and accurate alignment. The circuit-breaker unit is raised or lowered by a heavy steel square thread jack-screw, engaging with a bronze self-aligning nut, operated through a ball-bearing gearbox to minimise the effort required. In the accompanying engraving, which shows the circuit breaker in the raised position, one of the arc control pots has been removed to show the contact assembly. The stationary housing for the truck is a complete structure for each unit, with two side frames to ensure rigidity and accurate location of the truck on the rails fitted in the base.

The isolating mechanism shutter gear is of the sliding plate type, which provides complete enclosure of the bus bar by earthed metal. Shutters can be padlocked in the closed position, and to allow for using feeder earthing equipment an auxiliary shutter provides for padlocking the bus-bar orifices independently. High quality porcelains, cemented into machined castings, insulate the bus-bar orifices. The bus bars themselves are mounted directly on the bus-bar spout insulators and are braced by a bakelite barrier between units. Bakelite secondary insulation without auxiliary compound or taping permits the inspection of joints or the making of extensions to be effected in the minimum time.



WITHDRAWABLE TRUCK WITH CIRCUIT BREAKER RAISED

A separate chamber houses the current transformers to allow for complete flexibility of accommodation, so that the cable boxes or outgoing terminal positions can be arranged to suit the required disposition of the cables. Access to the transformers, insulators and connection joints can be gained either from the top or from the back of the unit. No tape or compound is used on any joints. A separate terminal board is provided for the current transformer secondaries. The instrument and relay panel is a separate assembly comprising a raised panel hinged to a secondary terminal compartment, and providing ample space for inspection, identification and tracing of secondary wiring. This panel is mounted between extensions of the unit side frames and can be provided with different heights to suit the equipment specified. Mechanical interlocks ensure that, when the truck is in position, the circuit breaker cannot be raised or lowered unless it is open, and the truck is correctly registered and locked in the housing; furthermore, the circuit breaker cannot be raised unless the tank is fitted and bolted into position.

It is stated that the ALA.1 unit has been proved by all the type tests stipulated in B.S. 116, and by additional tests not so specified. Insulation has been subjected to special over-voltage and corona tests. Complete units, including current transformers, secondary plugs and sockets, and all auxiliary equipment have been subjected to tests with short-circuit currents of greater value than those required for the issue of an A.S.T.A. certificate.

The Production of Small Permanent Magnets

A NEW material, known as "Caslox," has been introduced by the Plessey Company, Ltd., of Ilford, Essex, for the manufacture of small magnets for radio and electrical equipment. It is a pressed powder permanent magnet material, consisting of a mixture of iron-cobalt oxides and a small quantity of plastic binder. With this new material, once the necessary moulding tools are made, magnets can be pressed out rapidly in any quantity. The magnets can be made to any required shape, and machining operations are eliminated.

It is stated by the maker that the density of "Caslox" is 3·2 grammes per c.c., it is a reasonably good insulator, and has a specific resistance of $0{\cdot}5 \times 10^6$ ohms per cm cube. It has a very high coercive force and therefore the influence of disturbing magnetic fields is small. When moulded, the material is reasonably stable at temperatures up to 70 deg, it is unaffected by humidity and by atmospheric impurities, and tests have shown that its shelf life is good, the material proving particularly stable over long periods of time.

Magnets of this material are particularly suitable for use in small motors and generators. The rotors of synchronous clock motors are a good example of small moulded magnets having a metal insert which can be produced quickly, easily and economically from the material without recourse to machining operations before use.

A Ratchet Screwdriver

AN all-metal ratchet screwdriver is now being made by Speed-Tools, Ltd., Vereker Buildings, Gresse Street, London, W.1. This tool has an auxiliary handle which can be swung down into a horizontal position, and used in conjunction with the ratchet gear to exert a powerful leverage on a screw. When not in use the auxiliary handle folds back over the handle proper, where it is held securely out of the way by a spring-loaded ball. When it is required for unscrewing purposes the ratchet mechanism of the tool can be reversed by movement of a small lever near the bottom of the handle.

The screwdriver has a blade, 6½in long, ⅛in wide and is 12in long over all. It weighs just over 1 lb.

Speed on Curves

THE decade preceding the outbreak of the war in 1939 saw a progressive increase in the speed of express passenger trains in many countries, including Great Britain. On the London and North Eastern Railway, high-speed passenger trains introduced during the period included the "Silver Jubilee" (King's Cross to Newcastle), 1935; the "Coronation" (King's Cross to Edinburgh), 1937, and the "West Riding Limited" (King's Cross to Leeds), 1937. The running of these trains raised certain problems in connection with track maintenance, not the least of which was the question of proper standards for the alignment and superelevation of curved track, and the establishment and subsequent maintenance of such tracks to the standards adopted.

It was clear that the standard for superelevation hitherto accepted would have to be re-examined, the need being to legislate for the running of trains over existing tracks at speeds substantially higher than those theoretically appropriate to the superelevation on the curves. In other words, it became necessary to run at high speed under conditions of "cant deficiency." A provisional standard was fixed whereby cant deficiency up to a maximum of 2½in might be permitted in certain circumstances. This standard continued in use up to the outbreak of war, when the running of high-speed trains was discontinued, and a general maximum speed of sixty miles per hour for all traffic was imposed.

The experience gained so far showed that although quite good results were obtained with the provisional standard, it was desirable to extend the study of the subject in order to evolve standards covering, in addition to superelevation, the form and dimensions of transition curves, and the design of high-speed junctions. Such standards moreover would not be confined to high-speed trains on first class or primary lines, but would legislate for all classes of line and all kinds of traffic. On the formation of a whole line department, a small committee was appointed to study the subject, the members being Mr. E. Bilham, Mr. M. G. Maycock, and Mr. I. Stewart, the last named being replaced after his retirement by Mr. W. L. Adamson.

This committee, after prolonged consideration, formulated rules which, together with the necessary explanatory matter, including a theoretical exposition of the principles involved, and a sheet of curves giving the rules in graphical form, were embodied in booklet form. The booklet has recently been issued by the chief engineer of the Company as Technical Booklet No. 11: "Speed on Curves."

The subject appeared to fall naturally into two main parts:—

(1) The determination of the amount of superelevation or cant to be applied to the track. This involves also the consideration of the permissible "cant deficiency."

(2) The determination of the permissible rates of change of cant and deficiency and their relation to the form and dimensions of the transition curve of the track.

The view has been taken that the most desirable cant is an "economic" cant, *i.e.*, that value of cant which will allow of even wear of the component parts of the track, avoiding both excessive thrust and side cut on the high rail of the curve or on the other hand flattening out of the low rail. The formula for "average speed of normal traffic" given in Article 11 of the booklet is intended to secure this result. The formula takes into account the weight as well as the speed of the traffic passing over the curve,* and equilibrium cant is provided for the "average speed" given by the formula.

Provision is made for the high-speed train by allowing it to run under cant deficiency conditions, and setting a limit to the permissible deficiency. It might happen in a particular case that in applying the "economic" cant rule, a preponderance of slow and heavy trains may so pull down the average speed for which equilibrium cant is to be provided as to call for a speed restriction to be imposed on the high-speed trains. The choice is then between adhering to the economic cant or raising the cant by the amount necessary to enable the high-speed train to run at the speed desired under conditions of maximum permissible cant deficiency. If this latter course is adopted, any uneven wear of track materials which may result must be accepted as part of the price to be paid for high speed. It is not easy to lay down a hard-and-fast rule for the cant to be adopted in these cases, and it appears that each case must be decided on its merits as a matter of policy.

The rule adopted for permissible cant deficiency makes the quantity a function of the cant. In the case of primary lines, deficiency varies by a straight line law from 3½in at zero cant to 1¾in at 6in (maximum) cant. Reduced deficiency with increasing cant is thought to be justified by the greater influence of track imperfections at the higher speeds associated with higher cants. The rule is empirical. The authors of the booklet know of no mathematical basis on which to found a rule for cant deficiency, and it has been necessary to depend on observation and experience. The values decided upon are thought to represent a satisfactory standard for the comfort and well-being of passengers and rolling stock with an ample margin of safety. Allowance has also been made in the rules for drivers' errors in exceeding any speed restrictions laid down, the allowance having been deduced from a large number of observations of actual cases.

The form adopted for transition curves is the cubic parabola, which has a constant rate of change of curvature, approximately. Since cant should be proportional to curvature, it should also change uniformly along the transition curve from zero at the entry to the transition curve from the straight, to the maximum value at the junction of the transition curve with the circular curve. By the same reasoning, if the circular curve is to be traversed under deficiency conditions, the cant deficiency should also change uniformly from zero to a maximum between the same points. The rates of change of cant and deficiency cannot be determined theoretically, and here again we can only specify values which experience and observaton show to be suitable. In the booklet a limiting rate of change† of 1¼in per second is taken for both cant and deficiency. This figure leads to the simple and convenient rule for the length of transition curves given in Article 4 of the booklet, whereby the length in feet is obtained by multiplying the maximum speed in miles per hour by the cant or deficiency in inches, whichever is the greater.

It is demonstrated in the booklet that the radial forces due to cant and radial acceleration act in opposite directions and that when running under deficiency conditions there is an unbalanced radial acceleration, which is proportional to deficiency. The deficiency rate of 1¼in per second is equivalent to a rate of change of unbalanced radial acceleration of 0·8ft per second per second in a second.‡ This value is thought to be such as to ensure comfortable running.

It is pointed out that it is the unbalanced acceleration which is taken into account, not the full value of the acceleration. Transition curves worked out on the full value would be longer, but there seems to be no necessity for them. That part of the radial acceleration which is balanced out by cant is not felt, and there is no need therefore to provide additional length of curve to take it up.

In conclusion it may be stated that experience by the railway concerned of the application of the rules in the booklet during the past year or two has, it is stated, confirmed their soundness in practice.

* See article by F. Rapley, "The Superelevation of Railway Curves," *Railway Gazette*, May 21st, 1943.

† See paper by Mr. J. Taylor Thompson, "Railway Track Work for High Speeds," read to the Yorkshire Association of the Institution of Civil Engineers, Session 1937–8, March 31, 1938.

‡ Mr. W. H. Shortt, in his paper, "A practical method for the improvement of Existing Railway Curves," "Proceedings," Institution of Civil Engineers, Vol. CLXXVI, 1909, recommends a rate of change of 1ft per sec. per sec. per sec.

Annual Report of the North of Scotland Hydro-Electric Board

THE North of Scotland Hydro-Electric Board's annual report for 1946, just published, states that the Board's hydro-electric constructional and electricity distribution programmes made good headway during the year, in spite of difficulties caused by shortages of materials and man-power.

The Board's programme has now reached a stage when it is beginning to have some effect on employment and on the social conditions of the people in the north of Scotland. Eight generation projects had been approved and seventeen distribution schemes, designed to benefit over 100,000 people in the Highlands, had been prepared by the Board by the end of 1946. Hydro-electric projects under construction were already giving employment to over 4000 British workers by the end of the year.

Major contracts for engineering works have been placed with seventy-three firms. The capacity of hydro-electric generating plant ordered by the Board by the end of 1946 totalled 374,000kW and consist of twenty-one machines. In addition, the Board has purchased or placed orders for fifty-six diesel generating sets with a total capacity of 17,500kW, to operate distribution schemes already approved for remote areas or to provide power for constructional purposes. The report details the progress of the construction of hydro-electric schemes at Loch Sloy, Morar, Lochalsh, Tummel-Garry, Fannich, Gairloch, Glen Affric and Cowal. When completed, these schemes will have a total average annual output of some 720,000,000 units of electricity.

Concentration of effort to make the earliest possible contribution to the country's supply of electricity did not retard the Board's programme for the promotion and planning of new schemes to utilise the water power resources of the Highlands. Considerable survey work was in hand during the year for the preparation of new constructional schemes.

Consumers in the Board's distribution area, states the report, are eager to avail themselves of electrical equipment, not only in their homes but in hotels, workshops, farms and crofts.

Shortage of materials, particularly wooden poles, delayed the erection of overhead lines and cables in the areas of the Lochalsh, Morar, Bute and South Cowal, Orkney and Skye distribution schemes, but a start has been made with the supply of electricity in Orkney, Lochalsh, Skye and Mallaig.

Nine distribution schemes, under construction or approved, will serve Lochalsh, Morar, Gairloch and Aultbea, Bute, South Cowal, Great Cumbrae, North Cowal, Orkney, Skye, Lochcarron and Arran. During the year eight further schemes were submitted to the Electricity Commissioners for approval. These schemes were for supplies in the districts of Ullapool and Lochinver, and the islands of Islay, Lewis, North and South Uist, Shetland, Harris and Barra.

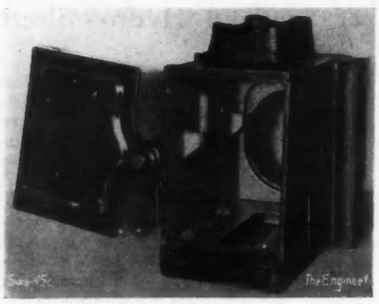
Six schemes, the preparation of which has been completed, will bring electricity to new areas—Lochaber, Mull and Iona, Seil, Luing

and Easdale, North Sutherland, Ardnamurchan and Little Loch Broom. Schemes are in preparation for the distribution of electricity in Glenelg, Applecross, Orkney (outer Isles), Coll and Tiree and Caithness.

The capital expenditure incurred by the Board during the year totalled £1,796,204.

Fabricated Steel Axleboxes on the L.N.E.R.

In 1935 the London and North Eastern Railway Company first introduced prototypes of all-steel welded axleboxes to its own designs. These boxes were subjected to the most severe tests in order to prove that the design and construction were satisfactory.



FABRICATED AXLEBOX

One of these tests included the fitting of a number of welded and C.I. axleboxes to condemned wagons. The wagons were then used to stage a collision and the results gained from this and similar tests proved the superiority of the welded axlebox.

Subsequently to these tests, a number of wagons were fitted with fabricated steel axleboxes and sent out for use in the roughest of traffic, including hump shunting, for 3½ years. During this period the axleboxes were under constant observation, the results being highly satisfactory, no cases of heating or breakage occurring. As a direct result of these tests in 1939 the necessary plant was ordered for the mass production of fabricated axleboxes at Shildon.

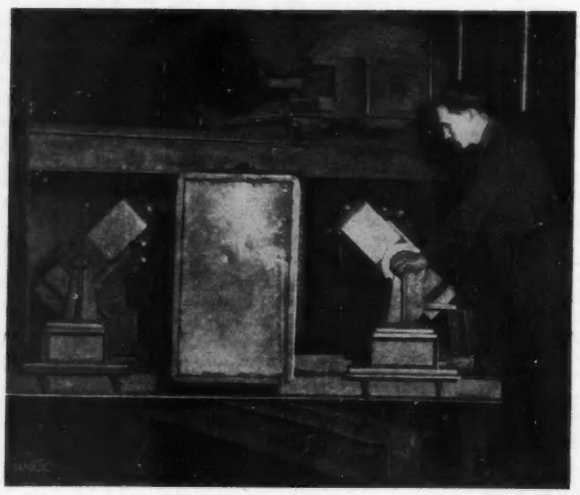
The new steel boxes proved stronger and lighter and, as they were designed to facilitate mass production by the automatic welding process, were cheaper to manufacture. The plant at Shildon has produced 70,780 axleboxes in a single year and to date nearly a quarter of a million boxes have been made.

A complete axlebox, such as is illustrated herewith is built up from twelve principal component parts.

At the plant laid down for the mass production of these axleboxes the plates, which are supplied in multiple sizes, are first cut into strips by guillotine shears. They then pass through blanking and bending presses of 250 and 300 tons capacity, on which the component parts are formed. Components then pass on to the assembly jigs and the automatic welding machines, of which there are six. These welding machines, shown herewith, are mounted on carriages. Each machine is served by a revolving table on which are mounted two jigs, one jig being set up with the necessary components whilst those in the other jig are being welded.

After inspection, the axlebox front face is milled, the lid securing lug drilled and the C.I. drawer and the lid fitted. The lid is held in position by a helical spring, a ⅝in bolt and nut and split pin. Finally, the axlebox is spray-painted.

We are informed that up to date three different sizes of axleboxes have been produced on this plant and the prototype axleboxes of a further two sizes have been completed.



ASSEMBLY JIGS AND AUTOMATIC WELDING MACHINES

British Iron and Steel Research Association's Sketty Hall Laboratories

On Thursday of last week, July 3rd, Sketty Hall was opened as the Swansea Research Laboratories of the British Iron and Steel Research Association.

To supplement the growing volume of research carried on by individual firms, the steel industry has decided to establish, through its industrial research association, a number of laboratories, of which Sketty Hall is one, for the purposes of co-operative research. At Sheffield University, a team is studying problems connected with rolling practice, and plans are well advanced for the establishment of a metal flow station in Sheffield, for practical investigations into all forms of metal working and plastic deformation problems; in London a physics laboratory is shortly to be opened; there is a corrosion-testing laboratory at Birmingham and a marine biological station at Millport, Scotland. The main function of these laboratories is to undertake investigations which lend themselves particularly to co-operative effort. In the main these lie somewhere between theoretical research carried out at universities and similar institutions and the practical or applied research which is carried out at the works of individual firms. At Swansea the majority of the work is concerned with metal surfaces and coatings on steel, though a limited amount of other work is also to be undertaken.

The organisation of the Swansea laboratories is the task of the Coatings Committee of the Mechanical Working Division of the Association, one of the six divisions under which B.I.S.R.A.'s work is organised. The greater portion of the work of Sketty Hall is to be carried out on behalf of the Coatings Committee, but work is also to be undertaken for the South Wales Steel Sub-Committee, part of B.I.S.R.A.'s Steel Making Division.

The terms of reference of the Coatings Committee are "To consider and investigate all matters concerning metallic and other inorganic coatings on steel and all processes for surface preparation associated therewith." This is, of course, a very wide field, involving close collaboration between research workers in allied fields and between research workers and users.

At the present time Mr. D. Luther Phillips, M.Sc., who is in charge of the laboratories, has a staff of nine full-time investigators who, together with research assistants, instrument mechanic, glass-blower, administrative staff, and so on, make up a total staff of about twenty.

The chemistry section has a spacious laboratory, and the metallurgical section has two laboratories, all on the ground floor. The metallurgical rooms are respectively equipped with various heat treatment furnaces and physical testing apparatus. On the same floor is a small workshop with an instrument mechanic's room adjacent, and the galvanising and tinning shop which will be sited in what seems to have formerly been a brew house. This shop is already furnished with ventilation for drawing off the brewery fumes, though the arrangements may have to be improved to dispose of the rather less appetising by-products of the shop's new functions.

The first floor provides two laboratories for the physics section, and two for the electrochemical section. The physics section, being engaged on investigating the geometrical and physical characteristics of metal surfaces, is equipped with a sensitive profilometer of the latest pattern, and will have electron diffraction equipment later in the year. The profilometer is a Talysurf machine, on which a stylus traverses the specimen and records the roughness of the surface on a graph, with an adjustable magnification of from 400 to 100,000 times. It was found necessary to install this equipment on a thoroughly stable base, and one of the physics laboratories has had to be provided with a ferro-concrete floor, on which the Talysurf and the electron diffraction apparatus are to be housed.

The second floor has comprehensive metallographic facilities, with separate preparation laboratory and photographic room.

There are many questions within the scope of the Coatings Committee crying out for answers. Among them are studies of metal surfaces, the thickness and distribution of coatings of various sorts, and of the porosity of coatings. In the continuing search for ever higher quality in coatings and for ever more economical methods of manufacture the Swansea team has already done considerable work on these subjects, which promises to be of ultimate benefit both to users and makers of the products concerned. There are various other problems which it will be the function of Sketty Hall to investigate. They include such questions as the influence of the composition of the steel and its method of manufacture on surface coatings; the physical and chemical characteristics of metal surfaces; the adhesion of coatings; electroplating; dewetting and others.

The work of the South Wales Steel Sub-Committee is defined: "To discuss and investigate the manufacture of steel for flat steel products." At Sketty Hall, projects undertaken on behalf of this sub-committee largely involve field tests on melting furnaces and works in the South Wales area. These projects are concerned with such matters as fuel distribution and gas flow in gas producers (in conjunction with the British Coal Utilisation Research Association); the effect of deterioration of ingot mould surfaces on the surface of the ingot and subsequent products; the determination of the moisture content of hot raw producer gas, and the assessment of the value of instrumentation of open hearth furnaces.

"Model Engineer" Exhibition, 1947.—It is announced that the twenty-second *Model Engineer* Exhibition will be open at the New Royal Horticultural Hall, Vincent Square, Westminster, S.W.1, on August 20th for ten days. A special feature of the exhibition this year will be an arena for working models, in which there will be frequent demonstrations of model ships and boats, and miniature petrol-driven racing cars in motion, and model aeroplanes in actual flight.

South African Engineering Notes

(By our South African Correspondent)

Merchant Shipping Bill

The Merchant Shipping Bill, which the Minister of Finance (Mr. J. H. Hofmeyr) introduced in the Assembly on May 26th, is a comprehensive measure dealing with all aspects of merchant shipping. Although, as the Minister stated in introducing the Bill, the measure would not be proceeded with until next year, it is reported on here purely for purposes of information, the subject being one of international importance. The Bill, which contains 437 sections and runs into 500 typewritten foolscap sheets in its draft form, is stated to be the longest measure ever introduced into Parliament, and represents several years of detailed investigation and research. Provision is made for the appointment of expert committees to advise the Minister on technical and other matters and there are wide provisions affecting the employment of seamen. The Minister is empowered to indicate by regulation the proportion of Union Nationals who must be employed on ships registered in the Union. Provision is also made for the appointment of a registrar-general of seamen and for officers, cadets, apprenticeship, certificates of competency, the registration of ships, courts of inquiry and courts of survey, dangerous cargoes, wrecks, the licensing of vessels, and the carriage of goods by sea generally. As far as possible, the Bill deals with essential principles providing a flexible rather than a rigid mechanism for dealing with shipping matters. One of the most difficult problems in the drafting of the Bill was the dovetailing of the various conventions dealing with such matters as the safety of life at sea, load-lines, radio-telegraphy, and general safety provisions. Air transport is covered in the Bill only to the extent of meeting cases where salvage operations are involved on aircraft which have crashed into the sea.

Hex River Tunnel and Other Railway Projects

The Hex River tunnel project, already reported on in the issue of THE ENGINEER, November 8, 1946, has now received its official send-off when the Minister of Transport (Mr. Claud Sturrock), on May 22nd, detonated forty charges of dynamite at the base of the Matroosberg in the Hex River mountains, to start the driving of the eight-mile tunnel which will replace the famous rail route over the pass. Referring to the project, Mr. Sturrock stated that the railways will be very busy in this area for many years to come. Besides the tunnel-building programme, the electrification of the line from Belville to Touws is about to be undertaken. Orders have been placed with South African industry to help it over the next few years, while the immigration policy should go a long way towards making up deficiencies in manpower. Large orders have been placed both in the Union and overseas for rolling stock, new engines and other equipment, while railway facilities such as marshalling yards, goods depots, and stations are being improved as rapidly as circumstances permit.

Liquid Fuel and Oil Bill

The object of the Liquid Fuel and Oil Bill, which was read a second time on May 21st, was, as stated by the Minister of Economic Development (Mr. S. F. Waterson), designed to give the necessary assurances and safeguards to justify private enterprise undertaking the development of an industry producing liquid fuel from coal and to ensure that national interests and the interests of the consumer would be fully protected. There are no known sources of liquid petroleum in the Union, which is almost completely dependent on outside supplies, but South Africa possesses vast supplies of low-grade coal, suitable for producing synthetic fuel. The present Government is satisfied that there have been great technological advances in recent years and that there are sound grounds for believing that oil can be economically produced in the Union from low-grade coal. The present known consumption of petrol in South Africa is about 200,000,000 gallons per annum, about half of which is consumed in the Transvaal. This, although not a large quantity, is likely to grow with the country's development. The Government is ready to encourage the industry provided there is a reasonable prospect of the fuel produced comparing in price and quality with imported products, and provided that the Union's natural resources were not wastefully used in developing it, and that the industry was not likely to become a burden on the State. The industry, when established, will give employment to many workers and will produce a number of by-products, thus leading to the establishment of a number of subsidiary industries based on these by-products. To be economical the industry will require to be established on a large scale and will cost between £10,000,000 and £15,000,000 to put into production. In view of the major importance of the industry and the amount of capital investment required, the Bill provides for the protection of the investor against the action of competitive concerns, which might involve the loss of capital invested. The Bill places the industry under supervision by a Board and the manufacturer is subject to the issue of licences. The terms of a licence provide that the manufacturer of liquid fuel will only be permitted to manufacture if the Government is assured that he is in a position to render satisfactory services to the country and that the issue of such a licence will be in the national interest. Provision is made in the Bill whereby, if necessary, the number of units manufacturing oil can be limited in terms of possible consumption. Also, in view of the protection which the industry will enjoy, provision is made for the control of profits, so that surplus profits can be shared between producer and consumer.

South African Branch of the British Institution of Production Engineers

As the result of comparatively recent negotiations, a meeting of the South African Association of Production Engineers was held on January 24th, to consider a resolution that the Association should become a Branch of the Institution of Production Engineers, Great Britain. The resolution was carried unanimously. Mr. D. Lion Cachet, the President of the Association, referring to this step, stated that all obstacles to the establishment of the Branch had been removed and that he felt it would be one of the greatest steps forward the Association had ever taken.

Tungsten Carbide and Small Tools Manufacture

A comparatively recent and interesting development within South African engineering industry is the production of tungsten carbide and small tools for the industry, as typified by the activities of W. S. Bell (Pty.), Ltd. This firm, which also imports Kennametal tungsten carbide products, English Steel Corporation small tools products, and Greenfield taps and dies, has been manufacturing for a few years past all types of carbide tools for the engineering industry, the tungsten carbide being either imported or manufactured on the premises from South African materials, depending on the use for which the tool is required. Special milling cutters, face cutters and drills are made up, as well as standard tools, and all types of tungsten carbide products, such as wire-drawing dies, wear-resisting parts, as well as punches and dies for special press work. Following extensive tests on rock drilling, carbide drill jumpers have been developed for the mining industry. They are reported to have given excellent results, the number of holes being greater than had previously been obtained with imported jumpers. Carbide tools for the woodworking industry are now being produced and have achieved a marked success. Whereas a high-speed steel has hitherto been used for woodworking knives, planer blades, router bits and saws, experience has proved that a longer tool life is obtainable with tungsten carbide. Other lines which have been successfully developed include special saws for cutting asbestos sheeting, mason's drills and glass drills.

South African Industrial Expansion

South Africa's industrial expansion in the last few years is reflected in the 1944–45 statistics of factories and productive industries (excluding mining and quarrying). Comparative figures from the Census of Industrial Undertakings just released show that between 1942–43 and 1944–45 the number of establishments increased from 9965 to 10,887, fixed capital from £140,578,000 to £170,213,000, and salaries and wages from £70,631,000 to £94,222,000. The gross value of output increased from £289,241,000 to £375,435,000, an increase of £86,194,000. Statistics for private establishments show that in 1944–45 10,405 establishments, with a fixed capital of £133,530,000, employed 431,403 workers, paid £80,321,000 in salaries and wages, and produced goods with a gross value of £341,255,000. The food and drink industry had the biggest gross value of output at £94,481,000. The clothing and textiles and the chemical industries each had an output valued at more than £31,000,000. The metals industry employed the largest number of workers—104,106—and the value of output in the 1291 engineering establishments was £63,300,000.

Coking Coal Reserves

The doubtful position of South African coking coal reserves, more particularly with regard to the later future of the steel industry, does not now appear to trouble the minds of the experts to the extent it has done in the past and also up to a comparatively recent date. Thus Dr. van der Bijl, chairman of the South African Iron and Steel Corporation, anticipates a time when the Union will be making steel without using coking coal and has even ventured to predict that this may occur within his lifetime. This is also the opinion of a recent visitor to the Union, Mr. A. G. Robiette, a partner in the firm of John Miles and Partners (London), Ltd. He considers that, though the Union's coking coal reserves are not very large, this should not make much difference to future development, since he is convinced that iron and steel processes within the next five or ten years will become independent of supplies of good coking coal.

Pressurisers for High Altitudes

Some very interesting and convincing tests have been recently carried out at Johannesburg (altitude about 6000ft) in the municipal engine test shop, on a typical 100 h.p. bus engine, using a pressuriser or supercharger which is a product of a British firm, Sir George Godfrey and Partners (S.A.), Ltd. When first tested in its normal (unpressurised) condition, the engine developed only 85·8 h.p. The pressuriser was installed under identical conditions, with the result that the power output was increased by 25·7 h.p., to a total of 111·5 h.p., thus improving the unpressurised performance by nearly 30 per cent, and increasing the manufacturer's rated sea-level output by 11·5 per cent. This remarkable result was achieved with a fuel consumption which was substantially lower than that obtained in the unpressurised condition. By means of a Farnborough electric indicator, it was further proved that the pressuriser could have no harmful effect on any part of the engine. This arises from the fact that the pressuriser was shown to impart better combustion characteristics to the engine with a consequent reduction of the load on the bearings generally. The present work of the company is looked upon as the nucleus of a South African organisation by means of which it is intended eventually to manufacture pressurisers in South Africa.

Industrial and Labour Notes

Railway Workers' Wages

A report was issued recently by the court of inquiry set up to examine applications by four trade unions representing railway employees who claimed increased wages and reduced hours of work. This report contains a number of specific recommendations, together with the court's overriding conclusion that there is an urgent need for detailed and exhaustive reconsideration of the whole grading of the various classes, scales and categories that make up the complicated structure of the railway service. The immediate proposals embodied in the report must, therefore, be regarded as a short-term arrangement.

It is recommended, for instance, as an interim measure that the basic rates involved in the various claims should be raised by 7s. 6d. per week with a corresponding increase of £19 10s. per annum in the case of salaried employees. It will be recalled that three of the four wage claims were for flat rate increases of 20s. per week. Three of the claims included an application for double-time remuneration on Sundays; here the court recommended no increase in the present rate which, broadly speaking, is time and three-quarters. Claims for shorter hours will be met, in part, by a recommendation for the introduction of a 44-hour week generally, and of a 42-hour week for clerical staffs, without loss of pay and without prejudice to any more favourable arrangements now operating.

A few days ago it was announced that two of the unions involved in the claims (the National Union of Railwaymen and the Associated Society of Locomotive Engineers and Firemen) had decided to accept as an interim measure the recommendations of the court of inquiry for an increase of 7s. 6d. weekly on the basis of a 44-hour week.

Double-Day Shift Working

In a written answer to a question in the House of Commons, the Minister of Labour commented on the report on double-day shift working (Cmd. 7147, H.M.S.O.) issued by the committee set up in March, 1945. Mr. Isaacs stated that the Government agreed with the view expressed in the report that, if we are to maintain and improve our standard of living without widespread increases in the working hours of individuals, there will have to be much more double-day shift working.

The Government also agree, said Mr. Isaacs, that workers will not accept the system unless they are convinced that its social inconveniences to themselves can and will be offset by compensating benefits. The more people there are working on the system in any area, the less the social disadvantages will tend to be; and the Government endorse the view of the committee that every effort should be made to adjust social and educational services to meet the needs of workers on double-day shifts.

At present, with certain special exceptions, shift working by workers other than adult males is prohibited by the Factory Acts. It is necessary therefore to consider how the Factory Acts could be modified so that they do not hamper planning of production on a two-shift basis, or hinder the progressive recognition of shift working as a normal arrangement. The Government accordingly propose to consult the National Joint Advisory Council on this matter and on the question of the morning and evening time limits within which the system should be made legal. This point is considered to be important because the advantages of double-day shift working are derived, in the main, from the longer hours for which plant can be worked.

Economic Planning

At his fortnightly press conference dealing with Britain's economic situation, held on Wednesday of last week, the Lord President of the Council, Mr. Herbert Morrison, stated that the Government was proposing to make a long-term economic plan for the country. So far, he said, planning had had to be short-term because of the many uncertainties and the changing circumstances of the immediate post-war years, and even now, there would always remain the uncertain factor of our international trading position. The Government, nevertheless, was drawing up a plan on lines as definite as may be practicable. Preliminary economic analyses and studies had been made and would be laid before the new Planning Board, one of the functions of which would be to advise upon the proper nature, limits and duration of the plan.

Dealing with exports, Mr. Morrison said that the question had been asked whether the original estimates of a loss of £200,000,000 in export trade as a result of the fuel crisis still stood. On present evidence, the Board of Trade adhered to that estimate, but it was felt that there might have been some misunderstanding about it. It was not, Mr. Morrison explained, a loss of £200,000,000 compared with the export target of £1,200,000,000 given in the White Paper, for that target had already been reduced on account of the fuel crisis by £100,000,000. The present estimate was, therefore, that exports this year might fall short by £100,000,000 of the total mentioned in the White Paper.

Joint Production Committees

A further expression of the Government's views regarding joint production committees was given last week in Parliament by the Minister of Labour, Mr. George Isaacs. He was asked what progress had been made in the setting up of joint production committees, and in which industries they were most strongly established.

In his reply, the Minister stated that the National Joint Advisory Council had approved the principle of the setting up of joint consultative machinery, where it did not already exist, provided, of course, that it was voluntary and advisory in character. It was stipulated also that this consultative machinery should not deal with questions relating to terms and conditions of employment which were normally dealt with through the ordinary means of joint negotiation, and that it must be left to each industry to adjust the form of joint consultative machinery to its own particular circumstances.

Mr. Isaacs said that the British Employers' Confederation and the general council of the Trades Union Congress had agreed to bring this recommendation to the notice of employers' organisations and trade unions respectively, and he was consulting with the National Joint Advisory Council as to the means by which his department could best be of assistance in this important development. He regretted, however, that he had insufficient information to enable him to reply to the second part of the question regarding industries in which joint production committees were most strongly established.

Sweden and the Five-Day Week

The latest issue of *The Anglo-Swedish Review* records that the Swedish Federation of Trade Unions has been discussing suggestions for shortening the working week to five days during the months of June, July and August, with a corresponding lengthening of hours over the rest of the year. The proposal, it was stated, had support from representatives of the engineering unions, who reported that local arrangements of the kind were being concluded without consultation with the union leaders, with the result that the situation was becoming chaotic, workers in many instances simply absenting themselves on Saturday. Representatives of other unions also expressed serious doubts about the desirability and practicability of the arrangements, some saying that in their particular industries they could not be worked at all.

The chairman of the Swedish Federation of Trade Unions pointed out that the attitude of the executive was that circumstances did not now allow a general shortening of working hours. Neither was he in favour of a compensated five-day week in the summer months, particularly in view of the consequences such arrangements might have in future actions for longer holidays.

Trade Disputes

The number of industrial disputes involving stoppages of work in the United Kingdom, reported to the Ministry of Labour as beginning during the month of May, was 100, and in addition there were 24 stoppages, which began before May, still in progress at some time during that month. These 124 stoppages involved altogether about 70,200 workers and were responsible for an aggregate loss of 181,000 working days. Comparative figures for the month of April were 251 stoppages in progress, involving 68,500 people and causing a loss of 240,000 working days. Of the stoppages of work which were taking place during May, 61 occurred in the coal mining industry, involving 43,100 workers and causing a loss of 99,000 working days, while 28 occurred in the metal, engineering and shipbuilding industries, involving 4100 people and resulting in a loss of 20,000 working days.

In quoting these figures, *The Ministry of Labour Gazette* has given also some details about the duration of the 109 stoppages of work through disputes which ended during May. There were 35 which lasted not more than one day; 25 lasted two days; 12 lasted three days; 20 lasted from four to six days; and 17 lasted over six days.

Purchase and Sale of Non-Ferrous Metals

The annual general meeting of the British Non-Ferrous Metals Federation was held in Birmingham on Thursday of last week, July 3rd. Following a report on the year's work, which was presented by the President, Mr. Horace W. Clarke, a discussion took place upon future arrangements for the purchase and sale of non-ferrous metals.

Attention was called to the announcement of the reopening of the Futures Market in New York for the forward purchase of copper and zinc, and the President announced that the Federation would shortly be making representations to the Government stating that the industry was concerned about the continuance of bulk purchasing and considered that the time was approaching when the ban might be lifted from the London Metal Exchange. Before that was done, however, the industry would wish to be assured of adequate safeguards to prevent undue speculation, and the exploitation of the consumer.

Manufacturers and the Civil Service

The National Union of Manufacturers has recently expressed, in a letter to the Prime Minister, its disappointment that the Cabinet directive for reductions in the Civil Service is not being implemented. The letter asks that the directive for reduction should be made effective and that there should be a thorough overhaul of the functions and methods of the Civil Service in order to make the most effective use of human effort and to avoid the draining of labour from industry.

The National Union also stresses that the country simply cannot afford to carry the burden of a Civil Service of the present magnitude if it is to recover its economic health and reach the level of production so urgently necessary for the maintenance of our standard of life.

It may be recalled that the Prime Minister, replying recently to a question in Parliament on the subject, said that the Government fully recognised the importance of limiting to a minimum the demands which civil administration made on the manpower of the country, and that a constant check was being kept in order to avoid waste and make the most economical use of existing staff.

French Engineering News

(From our French Correspondent)

PARIS, July 4th.

Conversion in industry to the use of heavy oil for heating is unlikely to become widespread if the present Government attitude persists. Prospective users are deterred by the slight advantages compared with the use of coal and also by the heavy cost of equipment. The Direction of Industrial Co-ordination seems to prefer a slower recovery within the framework of collective programmes, and is opposed to the disruption of the present equilibrium established between producers. Also, while supplies of fuel oil are relatively satisfactory, distribution possibilities are limited.

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In the steel modernisation plan considerable use will be made of pure magnesian limestone in the construction of linings for Martin and electric ovens. For some years the use of basic linings to give hearths proof against the hygrometric action of air when ovens are idle has been studied. The limestone found at Septemes, which has been widely used abroad, will, it is thought, provide the necessary materials for hearth construction under the plan.

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It is possible that allocations of steel to the S.N.C.F. may be reduced in favour of the automobile industry. The technical service of the S.N.C.F. has denied such a plan, stating that present allocations of raw materials to the railways are insufficient to justify such action. It is a fact, however, that if certain automobile factories are allowed extra steel the railways' requirements will have to be reduced, unless production increases.

* * *

The one Martin oven working on natural gas which France possesses produces 25,000 tons of steel, rolled in adjoining mills, without the use of coal. It is situated at Toulouse, and is owned by the Ferronneries du Midi. There is some concern over the fact that the Monnet Plan did not expressly envisage the maintenance of this oven. A solution to the problem is being sought by the qualified authorities.

* * *

Electrification in the French mines is proceeding slowly. The old steam-driven pumps are being replaced by 3000V or 5000V electric pumps; lighting of galleries by arc lamps is giving way to metal filament lamps, at intervals of ten to fifteen metres, and winches are being equipped with electric motors. Electrical equipment has not yet reached the coal face, however, but the direction of the Nord and Pas de Calais mines has decided to equip several pits with electricity, keeping the use of compressed air only for a small part of the equipment. Conveyors and the small cutting plant ventilators will be driven by flameproof motors fed by 3000/550V transformers.

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Monsieur Duguet, President of Charbonnages de France, has recently given a *résumé* of the first achievements and results of nationalisation of the coal industry. He stated that in the first five months of 1947 production was 2,000,000 tons greater than in the corresponding period in the preceding year. Daily output rose from 75,000 tons to 110,000 tons. While it is true that there has been an increase in numbers employed in the mines, Monsieur Duguet pointed out that this is due to special conditions including the fact that repairs and replacements of material which would normally have been left to outside firms before the war now have to be done by workshops specially created for the purpose. The same is true of dwellings which have partly been constructed by the mines, and not completely by builders as before the war. Many workers are also employed on new projects, benefits of which will not be apparent for several years. A very hopeful sign, thought Monsieur Duguet, was the fact that 25,000 new miners had been recruited, in two years, not counting prisoners, whose work was considerably inferior to free labour.

Notes and Memoranda

Air and Water

INTERNATIONAL LOAD LINE CONVENTION.—The Ministry of Transport has been notified that the Government of the Union of South Africa has acceded to the International Load Line Convention, 1930, with effect from May 24, 1947.

L.M.S. HEYSHAM-BELFAST SAILINGS.—The London, Midland and Scottish Railway announces that sailings on the Heysham-Belfast Irish cross-channel route are being increased to once daily in each direction on weekdays from July 7th to August 30th, 1947, inclusive. In addition, a relief steamer will duplicate the sailings from Heysham on Fridays and from Belfast on Saturdays during the same period.

INSTITUTION OF NAVAL ARCHITECTS.—The autumn meeting of the Institution of Naval Architects is to be held in Portsmouth and Southampton from Tuesday to Friday, September 23rd to 26th. The headquarters at Portsmouth will be at the Municipal College, where papers will be presented for discussion on September 23rd. Visits to the Admiralty Experiment Works, Haslar, and to H.M. Dockyard, and the Bridgemary Housing Estate, Gosport, will be made on September 23rd and 24th. On September 25th technical meetings will be held at the Civic Centre, Southampton, and there will be an evening trip to Winchester or the New Forest, or a visit to a liner in port. On September 26th a visit is planned to the Woolston Works of J. I. Thornycroft and Co., Ltd., followed by a sea trip in M.V. "Vecta."

ROYAL DUTCH AIRLINES MERGER.—According to information from Batavia, K.L.M. Royal Dutch Airlines are to operate the inter-island services in the Netherlands East Indies formerly flown by the K.N.I.L.M. (Royal Netherlands East Indies Airways) pending the formation of a Federated Indonesian Air Transport Organisation at some future date. K.N.I.L.M. aircraft and personnel will be taken over by K.L.M., and air services in the East Indies will be operated under the control of the Minister of Transport and Public Works. Towards the end of last year K.N.I.L.M. carried out several proving flights between Batavia and Los Angeles with a view to opening a trans-Pacific air service between the Netherlands East Indies and the United States. Proposals for the expansion of Kemajoran Airport (Batavia) have already been accepted. It is planned to extend the main runway, at present 1600 yards long, to take aircraft weighing up to 45 tons.

AIRCRAFT OPERATING WEIGHTS.—A study has been made by the Australian Department of Civil Aviation of the monthly variation of density altitude throughout the year at many points within Australia, and it is now proposed to permit an increase in take-off weight of aircraft appropriate to the seasonal decrease in density altitude at the aerodrome in question. This study, it is reported, revealed that a month by month variation in take-off weight, which would itself be embarrassing to operators could hardly be justified, and for that reason three seasons have been chosen, Summer (December 1st to February 28th), Mid-season (March 1st to May 31st and September 1st to November 30th), and Winter (June 1st to August 31st). Take-off weights have been computed for all appropriate airports throughout Australia on this basis for Douglas DC-4, Douglas DC-3 and Avro Anson aircraft, and it is proposed to issue similar tabulations for other types of aircraft. The table at present is limited purely to a statement of summer and mid-season weights, but winter weights will be added in the near future. Sanctioned take-off loads at Essendon airport (Victoria) are 65,000 lb (summer), 65,700 lb (in mid-season), and 70,500 lb in winter.

Miscellanea

CRUCIBLE CAST STEEL.—An interesting little brochure has been published by John Vessey and Sons, Ltd., Denby Street, Sheffield, entitled "Crucible Cast Steel." In simple, non-technical language, it traces the history and describes the manufacture of cast steel.

NICKEL CAST IRON FOR ENGINEERS.—The Mond Nickel Company, Ltd., has now issued a revised reprint of its publication, "Nickel Cast Iron for Engineers." It describes the various types of alloy cast irons obtainable by the use of nickel, and their mechanical properties. Copies of the publication may be had upon application to the company's offices, Grosvenor House, Park Lane, London, W.1.

INTERNATIONAL CONGRESS FOR ENGINEERING EDUCATION AT DARMSTADT.—An International meeting will be arranged by the Technische Hochschule Darmstadt, dealing with problems of technical education. It will take place from July 31 to August 9, 1947. Well-known scientists and engineers from many countries will present papers.

TECHNICAL REPORT ON THE RUHR COALFIELD.—Appendix No. 13 to the Technical Report on the Ruhr Coalfield is entitled "Modern Practice in the Driving of Stone Mines," and has now been published by H.M. Stationery Office, price 9d. net. This appendix is a translation of an article by Dr. Ing. Fritz Benthaus on mechanising the driving of roadways in stone, and on the use of "hard metal" bits.

AMERICAN IRON ORE PRODUCTION.—Statistics compiled by the U.S. Bureau of Mines show that the output of iron ore increased in all districts of the U.S.A. in the month of March, the month's production totalling 2,846,168 tons, compared with 2,590,928 tons in February. The domestic mine stocks of iron ore at the end of March were 9,825,081 tons, compared with 8,404,113 tons at the end of February.

THE APPLICATION OF SWITCH FUSES.—A useful review of the main technical considerations relating to the safe and economical application of switch fuse protection is contained in a ten-page booklet (No. C550), by W. Davies and P. J. Shipton, published by Cantic Switches, Ltd., Chester. The principles of design are outlined and reference is made to types of fuses, their selection, open-phase protection and certain applications involving special fuse characteristics. A limited number of copies will be available to responsible engineers, on request, from the publishers.

ELECTRICITY BOARD FOR NORTHERN IRELAND.—The fifteenth annual report of the Electricity Board for Northern Ireland shows that, in the first full year of trading since the war the total number of units sold was 111,135,000, an increase of nearly ten million units compared with the previous year. In 1946 revenue income rose from £630,001 to £700,133 and expenditure from £486,912 to £551,880, so that the credit balance for the year was £148,253. Since 1939 the costs of current and management had increased substantially, due to rises in the price of coal and increases in salaries and wages. In spite of these rises the cost of current had been reduced from 1·51d. per unit in 1939, to 1·42d. per unit in 1946 and no change is contemplated at present. As from June 30, 1947, the Board acquired the undertakings of Antrim Electricity Supply Company, Ltd., and Antrim Electricity Distribution Company, Ltd.

POWER SUPPLY FOR WESTERN EXTENSION OF CENTRAL LINE.—The power supply for the Western Extension of the Central Line from North Acton to Ruislip will be provided by the Metropolitan Electric Supply Company. This supply will be transmitted by cable at 22kV, 50 cycles per second, to five substations, where the power will be converted to 630V d.c. for distribution to the conductor rails. The high voltage cable forms two loops, the first of which feeds the substations at Old Oak Common, Greenford and Ruislip, while the second loop supplies the intermediate substations at Brentham and Northolt. Each substation is equipped with 1500kW water-cooled steel tank rectifiers, together with step-down transformers and the appropriate a.c. and d.c. switchgear. Supervisory control over each of the substations is maintained from a single switchboard in the Old Oak Common substation, the remaining four stations being unattended.

NEW POWDERS FOR FLUORESCENT TUBES.—The new high efficiency fluorescent powders that were discovered and developed at the Research Laboratories of the General Electric Company, Ltd., Magnet House, Kingsway, W.C.2, for use in 4ft and 5ft Osram fluorescent lamps, are now being used in high tension fluorescent tubes. As in the case of the 4ft and 5ft lamps, the efficiencies of the h.t. tubes have been considerably improved. An indication of the improvement is given in the following comparison. It is claimed that the initial efficiency (after 100 hours) has been raised from 31 lumens to 40 lumens per watt, the average efficiency throughout life is now increased from 24 lumens to 31 lumens per watt, while the final efficiency of the new lamp is 26 lumens instead of 22 lumens per watt. Furthermore, the average life has been increased by approximately 67 per cent. These achievements, which were first incorporated in 4ft and 5ft daylight fluorescent lamps, have therefore been extended to include warm white colours, bringing the efficiencies of these colours to the same level.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chemical Society.

Tuesday, July 15th, to Thursday, July 17th.—Centenary celebrations in London.

Thursday, July 17th, to Thursday, July 24th.—Eleventh International Congress of Pure and Applied Chemistry in London.

Engineering and Marine Exhibition

Thursday, August 28th, to Saturday, September 13th.—London, Olympia.

Institute of Physics

Friday and Saturday, July 18th and 19th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. A Symposium on "Methods of Crack Detection."

Institution of Electrical Engineers

Saturday, July 26th.—N. MIDLAND STUDENTS: Summer Outing. 9 a.m.

Institution of Naval Architects

Tuesday, September 23rd, to Friday, September 26th.—Autumn meetings at Portsmouth and Southampton.

Iron and Steel Institute

Wednesday, July 9th, to Friday, July 18th.—Summer meeting in Switzerland.

Public Works Congress and Exhibition

Monday, July 21st, to Saturday, July 26th.—London, Olympia.

Stephenson Locomotive Society

Sunday, July 20th.—NORTHERN BRANCH: Visit to Hull Running Sheds, L.N.E.R. 2.30 p.m.

Thursday, July 24th.—Visit to Willesden Locomotive Depot, L.M.S.R. 6 p.m.

Personal and Business

P.R.T. LABORATORIES, Ltd., High Wycombe, Bucks, will in future be known as Airmec Laboratories, Ltd.

MACROME, Ltd., announces the appointment of Mr. P. W. D. Winkley as branch manager of the Manchester office.

ACHESON COLLOIDS, Ltd., 9, Gayfere Street, Westminster, S.W.1, has been registered to take over the business hitherto carried on under the title of E. G. Acheson, Ltd.

MR. HORACE W. CLARKE has been elected President of the British Non-Ferrous Metals Federation. Mr. W. H. Henman, Mr. H. E. Jackson and Mr. W. J. Terry have been elected Vice-Presidents.

MR. J. HERBERT ASTON has retired from the board of Tube Investments, Ltd.; Mr. M. A. Wolff has resigned from the board of the parent company, but retains his appointments with the subsidiaries; Mr. E. Austyn Reynolds has relinquished his appointment as an assistant managing director, but retains his seat on the board; and Mr. M. R. Reeve has been elected a director.

Launches and Trial Trips

SEKONDI, motor cargo liner; built by the Furness Shipbuilding Company, Ltd., for Elder Dempster Lines, Ltd.; length 385ft, breadth 57ft, depth 32ft 9in; 6000 tons deadweight. Engines, four-cylinder Doxford opposed-piston oil of 3100 b.h.p., supplied by Richardsons, Westgarth and Co., Ltd. Launch, June 17th.

KANTARA, motor cargo vessel; built by Harland and Wolff, Ltd., for the Moss Hutchison Line; length 367ft, breadth 52ft, depth 32ft 6in; gross tonnage, 3350. Engines, single-acting, four-cycle, crosshead type, Harland-B. and W. diesel, with six cylinders, 650mm bore by 1400mm stroke. Launch, June 3rd.

SALAGA, cargo vessel; built by R. and W. Hawthorn, Leslie and Co., Ltd., for Elder Dempster Lines, Ltd.; length 385ft, breadth 57ft, depth 32ft 9in; 6000 tons deadweight. Engines, four-cylinder Hawthorn-Doxford, opposed-piston, cylinders 560mm bore by 2160mm combined stroke. Launch, June 18th.

HYALINA, turbo-electric tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for the Anglo-Saxon Petroleum Company, Ltd.; length 550ft, breadth 70ft, depth 40ft 6in.; gross tonnage 12,600. Engines, turbo-electric, developing 11,000 s.h.p., supplied by the British Thomson-Houston Company, Ltd. Launch, June 19th.

HARFALION, motor cargo vessel; built by Burntisland Shipbuilding Company, Ltd., for the National Steamship Company, Ltd.; length 445ft, breadth 59ft 6in, depth 37ft 7in; gross tonnage, 5441. Engines, four-cylinder Doxford, opposed-piston, reversible oil, cylinders 600mm bore by 2320mm combined stroke. Trials completed, May 24th.

IMPERIAL STAR, refrigerated cargo liner; built by Harland and Wolff, Ltd., for the Blue Star Line, Ltd.; length 540ft, breadth 70ft, depth 43ft 4½in; gross tonnage, 13,500. Engines, two sets of reversible two-cycle, double-acting, Harland-B. and W. diesel, each having eight cylinders, 620mm bore by 1400mm stroke. Launch, June 17th.

DWARKA, passenger ship; built by Swan, Hunter and Wigham Richardson, Ltd., for the British India Steam Navigation Company, Ltd.; length 375ft, breadth 54ft 6in, depth 27ft; 4500 tons deadweight. Engines, single set of Swan, Hunter-Doxford opposed-piston diesel, with five cylinders, 600mm bore by 2000mm combined stroke. Trials completed, June 19th.

LANGLEESCOT, cargo liner; built by Blythswood Ship Building Company, Ltd., for the Medomsley Steam Shipping Company, Ltd.; length, 486ft, breadth 62ft 6in, depth 41ft 6in., 10,500 tons deadweight. Engines, set of single-screw Doxford opposed-piston, two-cycle, airless injection, with six cylinders, 670mm bore by 2320mm combined stroke. Trial trip, June 25th.

LAMPANIA, motor tanker; built by R. and W. Hawthorn, Leslie and Co., Ltd., for the Anglo-Saxon Petroleum Company, Ltd.; length 446ft, breadth 54ft 3in, depth 31ft; 9000 tons deadweight. Engines, single-screw set of Hawthorn-Werkspoor four-cycle supercharged airless injection type, cylinders, 650mm bore by 1400mm stroke, developing 2700 b.h.p. Trials completed, May 29th.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of Report.	Title.	Post free. s.	d.
C.I.O.S. XXVIII			
53	Walter Werke, Kiel: Propulsive Ducts and Rocket Motors	1	7
F.I.A.T.			
655	Synthetic Sapphire and Spinel Production in Germany	1	7
706	Report on Selenium Dry Rectifier Developments	5	2
798	Titanium Metal Produced by Degussa and Osram	1	1
812	The Aluna Process: Method of making diazo types by first photo-printing	1	1
B.I.O.S.			
775	Manufacture of Butanol, Methoxybutanol, Butyraldehyde, Glycerogen, at I. G. Hoechst ...	2	1
768	The German Automobile Industry	6	3
775	Investigation into Steel Shaving Machines in the French Zone of Germany	0	7
792	Properties and Testing of Rubber: Interrogation of Dr. P. Stocklin at Beltane Schools, S.W.19	1	7
793	German Production of Galvanised Hot-Tinned and Enamelled Hollow-Ware	5	8
800	Chemistry of Polymerisation as applied to the Preparation of Buna Synthetic Rubbers: Interview with Dr. Becker ...	1	7
805	Aspects of the Synthetic Fatty Acid and Synthetic Fat Industries in Germany...	11	3
F.I.A.T.			
102	New Radial Flow Turbine Design	1	1
376	Quadrant Type Electric Steering Gear for the German 5000-ton and 9000-ton Hansa Ship Programme; also other Electric Steering Gear	1	7
393	Automatic Bar Machines Manufactured by Alfred H. Schutte at Koln-Deutz	1	1
397	Survey of the Carbon and Graphite Electrode Industry of Germany	2	7
430	Survey of the Soda Ash and Caustic Soda Plants of Western and Southern Germany	2	7
447	Study of Production of Shale Oil from Shale in Wurttemburg	9	3
512	Survey of Low Voltage, Air Circuit Breaker Practice, Germany	3	2
600	Air Filters and Oil Filters for Engines	1	7
733	Vertical Retort Zinc and By-Products	3	2
744	Salicylic Acid	1	1
786	The Lithium Electrolytic Cell (Degussa, Rheinfelden)	1	1
789	Experiments to Produce Ductile Silicon	1	1
J.I.O.A.			
50	Observations on the German Fruit Juice Industry...	1	7
B.I.O.S.			
629	Investigation of Synthetic Resins used in the German Surface Coating Industry	12	3
660	Ruetgerswerke A. G. Rauxel: Distillation of Coke Oven Tar ...	2	1
699	Methods of Production in Germany of General Heavy Forgings and Railway Axles, Tyres and Wheels	5	8
722	Lurgi Gesellschaft fuer Warmetechnik, Frankfurt: High-Pressure Gasification of Brown Coal	1	7
723	German Feather Industry	2	7
724	Electronic Principles as applied in Germany to the Testing of Materials	16	10
732	Luenburger Wachswerke A. G. Luenburg—Germany: Waxes	2	1
733	Brewing and Malting Machinery: Seitz Filter Media	3	8
736	Chemical Laboratory Instrumentation in Germany	3	2
739	Maleic Anhydride by Oxidation of Crotonaldehyde at I. G. Ludwigshafen	0	7
742	Preparation and Polymerisation of Vinyl Ethers and Preparation of Acetaldehyde from Methyl Vinyl Ether at I. G. Farbenindustrie, Ludwigshafen	1	1
744	Manufacture of Vinyl Acetate Polymers and Derivatives at I. G. Hoechst	1	7
745	Manufacture of Monomeric Vinyl Acetate at I. G. Hoechst	1	1
746	Vinyl Carbazole and Vinyl Pyrollidone at I. G. Ludwigshafen ...	0	7
747	Acetylene by the Arc, also the Oxosynthesis at Ruhrchemie, Holten...	0	7
763	Identification of Dyestuffs in I. G.	1	7
772	Manufacture of Diazo Chemicals, Kalle and Co., Wiesbaden/Biebrich	2	1
776	Manufacture of Ethylene Oxide, Ethylene Glycols and Ethylene Chloride at I. G. Farbenfabrik, Wolfen	4	8
787	Report on German Engineers' Tool Industry	19	5
804	The German Herring Curing and Herring Canning Industries ...	2	1
813	Zinc Works at Porto Marghera, Italy (Montecatina—Montevecchio, Soc. Italiana del Piombo e dello Zinco)	4	2
824	Rolling Mills: Notes on German Practice	14	4
829	German Agricultural Engineering Industry	3	2
839	Report on Investigation of Methods of Gaseous Metal Treatment	2	1
851	I. G. Hoechst: Chlorinated Methane Derivatives	1	7
852	I. G. Leverkusen: Hydrofluoric Acid	1	1
863	Production of Liquid Sulphur Dioxide at I. G. Farbenfabrik, Wolfen	2	1
877	Oxidation of Hydrocarbons to Ethylene and of Methane to Acetylene, with Conversion of Acetylene to Acetone I. G. Oppau	1	1
F.I.A.T.			
378	Bohn and Kaehler A. G. Kiel, Germany: Small Vertical Steam Engines for driving generators, &c.	1	1
525	Poppet Valves for Automotive and Aircraft Engines...	2	1
582	Thread Rolling Process for Finned Radiator Tubes	0	7
609	High Power Radar Jagdhaus ...	1	7
640	Kloeckner Humboldt Deutz (Magirus) 70 h.p. Water-Cooled and Air-Cooled Truck Diesel Engines	3	2
699	Magnesium Determinations in Aluminium	0	7
J.I.O.A.			
35	Report on Solid Fuels...	3	2
B.I.O.S.			
537 (Appendix)	Investigation of Production Control and Organisation in German Factories (Appendix): Production Control in the Heinkel Aircraft Organisation...	4	8
644	Detonator Factory, D.A.G., Troisdorf	2	1

B.I.O.S. Information Section, 37, Bryanston Square, W.1., which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive inquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

British Scientific Instrument Research Association

At a luncheon held in London on Thursday, July 10th, to celebrate the official opening of the new laboratories of the British Scientific Instrument Research Association at Southill, Elmstead Woods, Chislehurst, Sir Edward Appleton, F.R.S., Secretary of the Department of Scientific and Industrial Research, spoke on the future of the scientific instrument industry. He pointed out that the industry was situated at the corner of a triangle, the other corners being occupied by science and by the users of instruments. From the development of science came the warp and weft, from which the fabric of instruments was made, and from the users came the prompting of definite objects. It might be a graticule, a quantitive aid to vision, which played an important part in the late war, or it might be a carbon dioxide recorder to control the breathing of apples during their long journey from the Dominions to the Mother Country. It was, he went on to say, a good thing to have such stimulation from the user. In its move towards greater efficiency, British industry, Sir Edward said, would make more exacting demands on the ideas and products of the British Scientific Instruments Research Association, and he was confident that the challenge would be courageously and strenuously accepted. The address of the new laboratories is "Sira," Southill, Elmstead Woods, Chislehurst, Kent, and the telephone number IMPerial 2237. The laboratory is best reached from Elmstead Woods Station.

New Flotilla Leader H.M.S. "Agincourt"

It can now be stated that the new flotilla leader, H.M.S. "Agincourt," which has been built and engined by R. and W. Hawthorn, Leslie and Co., Ltd., on the Tyne, was commissioned on June 11th and proceeded on her official sea trials on Tuesday, June 17th. Those trials were satisfactorily completed and the ship was handed over to the Admiralty on Wednesday, June 25th. The "Agincourt" is one of the flotilla leaders provided for in the 1943 naval programme. She has a displacement of about 2200 tons. Her armament comprises twin 4·5in quick-firing guns, twin 40-mm Bofors guns and 21in torpedo tubes. Her propelling machinery consists of a twin-shaft arrangement of modern geared turbines, having a designed output of 50,000 s.h.p., taking steam from oil-fired boilers. The new ship is under the command of Lieut.-Commander D. T. McBarnet, D.Sc., R.N. A sister ship, H.M.S. "Alamein," is also being completed by the firm. The "Agincourt" is the ninth flotilla leader completed by R. and W. Hawthorn, Leslie and Co., Ltd., of Hebburn Shipbuilding Yard, since 1939.

International Congress for Pure and Applied Chemistry

In a short article, already published in our issue of June 27th, we outlined the general scope of the papers to be read and discussed at the forthcoming eleventh International Congress of Pure and Applied Chemistry, which opened in London on Thursday, July 17th, and closes on Thursday, July 24th. A dinner will be held on Wednesday, July 23rd, at the Dorchester Hotel, to which Mr. C. R. Attlee, the Prime Minister, has been invited to attend. It can now be stated that about 2000 members, including 392 official delegates from twenty-six different countries, will attend the Congress. The number of delegates from the respective countries are as follows:—Great Britain, 144; France, 54; Italy, 41; United States, 26; British Commonwealth, including Australia, Canada, India, New Zealand and South Africa, 21; the Netherlands, 21; Belgium, 18; Denmark, 12; Czechoslovakia, 11; Switzerland, 9; Norway, 7; Eire, 5; Yugoslavia, 5; Sweden, 3; Poland, 3; Hungary, 3; Turkey, 2; and one each from Finland, Greece, Rumania, Spain, the Argentine, Uruguay and Venezuela. It is known that Soviet Russia will be represented by a delegation, the strength of which is not yet known, and the Russian Ambassador in London has accepted an invitation to be a member of the Committee of Honour of the Congress.

Economic Planning and the Direction of Labour

At the annual conference of the Transport and General Workers' Union, which is now being held in Hastings, the general secretary, Mr. A. Deakin, introduced on Tuesday, July 15th, the subject of economic planning. He put a resolution which requested the Government to examine the position, which would lead to a progressive reduction in the armed forces, having regard to the overall commitments, and to develop and make known its plans for mobilising all the resources of the country and, further, improving the efficiency of management. The resolution was carried almost unanimously. Mr. Deakin went on to say that in his opinion the proposals contained in the Government's economic survey barely pointed the way out of the present difficulties. It would be necessary to get very close to the means employed in wartime, and even to be prepared to accept a limited measure of direction. He felt that a great many people were not doing useful work, and there were thousands, he thought, who should be in productive industries if the nation's problem was to be substantially eased. Much progress, he said, could be made in increasing industrial efficiency by making use of improved technique and research; much, he felt, might be done to achieve better productive capacity. In order to bring about full production it would be necessary to remove some of the restrictive practices it had been necessary to employ for so long. One in particular was payment by results. The Transport and General Workers' Union had never had any fear or hesitation in accepting agreements which rewarded people according to services rendered, and the production achieved. Many of the wartime practices for increasing production must be resumed and the spirit of do or die which existed during the war, recovered. Ordered priority in production was needed, and he asked the delegates to create a sense of emergency among the union members. In the factory and the workshop men should be enabled clearly to understand what was needed of them.

Special Surveys and Load-Line Certificates

The General Committee of Lloyd's Register has now decided to revert to the special survey system of class maintenance as quickly as is possible, having due regard to the circumstances in the shipyards and repair establishments. Special surveys for Allied ships have now been generally suspended for seven years and it would not be practicable to insist immediately, at one and the same time, upon the overhaul and repair of all ships due for survey, having in mind the present world need of shipping space and the stringency still persisting in repair facilities and materials. So far as British ships are concerned, the matter has been fully discussed and reviewed with the Ministry of Transport and with the Admiralty, in which the Director of Merchant Ship Repairs is responsible for repair licences. As an initial step, a scheme for British ships has been formulated whereby facilities shall now be granted for full special surveys to be held on those ships which have not been specially surveyed for eight years or more. In addition, and subject to the above priority, it is desirable that, wherever possible, facilities should be obtained from the local licensing officers for special surveys to be carried out on new ships now due, or overdue, for their first periodical survey. In either category, however, if the repairs required for the full period of a special survey and load-line renewal are so extensive that their execution would unduly delay the return of the ship to service, consideration will be given to the issue of classification and load-line certificates for a shorter period, and only such repairs carried out as are essential for that period. The remainder of the vessels will have to await priority, and in these cases class maintenance will be continued by means of general examinations, the requirements of which have been somewhat strengthened. The present stringency in the steel situation may influence the extent to which these proposals can be carried out, but it is hoped that sufficient steel will be made available for the urgent cases which it is intended to deal with.

Anglo-Iranian Oil Production Progress

In a statement by Sir William Fraser, chairman of the Anglo-Iranian Oil Company, which accompanies the company's accounts for 1946, and which was issued on Monday, July 14th, some interesting facts appear, showing the progress which is being maintained by the undertaking. The production or throughput at Abadan last year was 17,673,000 tons, and it was higher than ever before. The company's fleet of tankers, about which he had earlier expressed the hope that it would soon be restored to its pre-war size of 1,000,000 tons, had actually reached at the end of 1946 nearly 1,100,000 tons, but it still remains inadequate, despite the chartering of U.S. tankers for single voyages and the purchase of four of these tankers. It seems likely that for some time at least the supply of new tanker tonnage will barely keep pace with the necessary replacement of old tonnage. Reference is also made in Sir William Fraser's statement to the announcement a few weeks ago of the arrangements made with the Standard Oil Company of New Jersey and the Socony Vacuum Oil Company for the construction of a pipe-line from the head of the Persian Gulf to the Mediterranean. An advantage will be the transport of oil through that new line for those companies, which will enable the Anglo-Iranian Company to increase its offtake of crude oil in a shorter time than would be possible if it had to wait for new refinery capacity, the acquisition of tankers and the development of market outlets. The route of the new pipe-line will be shorter by some 3000 miles than the sea route.

New Power Stations

According to a statement by the Ministry of Works, building and civil engineering work to the value of £75 million will be carried out on electric power stations during the next two years to help bridge the gap between the supply of electricity and the increasing industrial and domestic demands. This demand has been increasing at the rate of more than 700,000kW per annum and is still growing. Site work is in progress on sixty-three projects, which will house plant capable of generating more than 5,260,000kW. The plans have been approved for thirteen additional projects to provide a further 1,205,000kW, and site work will begin in the near future. It is also stated that a further programme for the next two years is being drawn up for more new stations or for extensions to existing stations. The Ministry of Works is making efforts to ensure that a continuous supply of materials will be available at the sites, and the Ministry of Labour is co-operating to ensure that the contractors have all the necessary men for the work. Some 8000 men are already engaged in the new work. An Interdepartmental Committee, on which is represented the Electricity Commission, Central Electricity Board, and the North of Scotland Hydro-Electric Board, sits under the chairmanship of a Ministry of Works official. Its terms of reference are to speed up the supply of labour and civil engineering resources required in connection with the provision of electricity generating capacity. Working parties have been appointed in England and Scotland to resolve the day-to-day problems.

Lighthouse Engineering

By K. C. SUTTON-JONES, Stud. Inst.C.E.

No. II—(*Continued from page 26, July 11th*)

THE luminary of perhaps the most universal application to lighthouses is the petroleum vapour burner, to which paraffin oil is supplied under pressure and is vaporised in a retort beneath the burner, being afterwards consumed in an incandescent mantle. Modern burners of this type have been devised by the late Mr. D. W. Hood, past engineer-in-chief, Trinity House, and by Messrs. Chance Brothers, of Birmingham. Autoform mantles of up to 110 mm diameter are employed—the intensity produced in a 110 mm mantle being over 3000 candles. At the Eddystone, which is equipped with

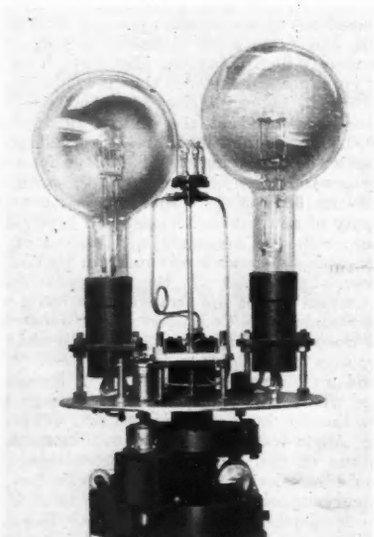

FIG. 6—AUTOMATIC LAMP CHANGER

Biform 1st Order apparatus, a 35 mm "Hood" burner is employed in each optical tier, giving a beam intensity of nearly 600,000 candles—the annual oil consumption being 700 gallons. "P.V." Burners, as they are termed, followed an era of wick burners, but they are themselves being gradually superseded by electric sources of light. Carbon arcs are still in use in some lightservices, although they have been discontinued in the British lightservices, mainly on account of high running cost. Being small, they produce little divergence in the emitted beam. Acetylene is employed extensively but is confined mainly to beacons and buoys and to standby illuminating systems. Kerosene, propane and coal gas together with other patent gases are employed —but mainly abroad. The principal lightsource of today is the gas-filled electric filament lamp, and it is largely due to the efforts of the present engineer-in-chief to the Trinity House that these lamps have been developed in this country. Such lamps are rated from some 15 watts to 6 kilowatts, and the filaments are specially designed to provide a luminous mass of great brilliancy, suitable for optics of differing arrangement (see a later article in this series).

It is becoming standard practice to provide standby lamps which can be "switched" into focus automatically upon failure of the main lamp. Many such ingenious devices have been introduced, both for replacing lamps and for coupling-up to a standby supply when the principal supply fails. "Lampchangers," as they are termed, are fitted within the lens and a typical example is shown in Fig. 6. In this particular lampchanger the operation is as follows: Upon the main lamp failing, the second electric lamp is brought into focus and connected to the supply automatically. Should the second lamp fail or the principal supply fail, the lamp table rotates automatically, to bring an acetylene burner into focus and at the same time the gas valve is opened and the burner is kindled by a small pilot jet. Upon a resumption of the principal supply, the lamp table again rotates, the gas valve is closed, and a sound electric lamp is selected and brought into focus with the lens and connected to the supply.

Burner and mantle changers are extensively employed, and one such is illustrated in Fig. 7. The gas is let in from above, the mantle being supported from below. Upon mantle breakage, the flame is diverted past the mantle and severs a wooden catch pin. This action sets a cam mechanism into operation, which brings the damaged mantle out of focus and replaces it by a sound mantle automatically.

Prior to the introduction of the mercury float pedestal arrangement, lighthouse optics were rotated upon rollers which involved considerable wear and the employment of powerful rotating mechanism. The larger types of optics are now supported upon a carriage which floats in a trough containing mercury, and friction is so reduced thereby that a gentle touch with the finger is sufficient to set the lens rotating freely. Smaller optics are now rotated on ball-bearing pedestals and both this and the mercury float pedestal permit a much more rapid revolution of the lens than was previously obtainable. In the past it was common for one revolution to be made by the optic in three or so minutes, but it is now usual to employ speeds of some fifteen seconds for a single revolution.

ROTATING AND FLASHING MECHANISMS

Weight-driven clocks still remain the principal means of rotating lighthouse optics, mainly upon grounds of their simplicity, although cases exist where the clock is rewound automatically by means of an electric motor and control gear. Modern design features many novel devices. In one such arrangement, electric motors are set in twin so that, upon the failure of one motor, the other is coupled to the optic drive and the supply transferred automatically. Where the power supply is not to be relied upon, the electric motor is arranged to provide the principal means of rotation and, upon power failure, the clockwork mechanism is automatically brought into service. This latter arrangement is favoured also where electrification of existing clock-driven equipment is required. Another novel means of driving the optic is to utilise the pressure of gas passing to the burner. A gas oscillator then operates a ratchet arrangement which, in turn, rotates the optic table.

The introduction of automatic features has necessitated the adoption of a comprehensive alarm system, which acquaints the keeper with the position within the lantern.

It will be visualised that rotating mechanisms are costly, and the further consideration of the increased power of modern lightsources has induced engineers to dispense with rotating apparatus for minor light stations and to utilise a "fixed" lens, incorporating a "flashing" lightsource. Although the fixed lens is much

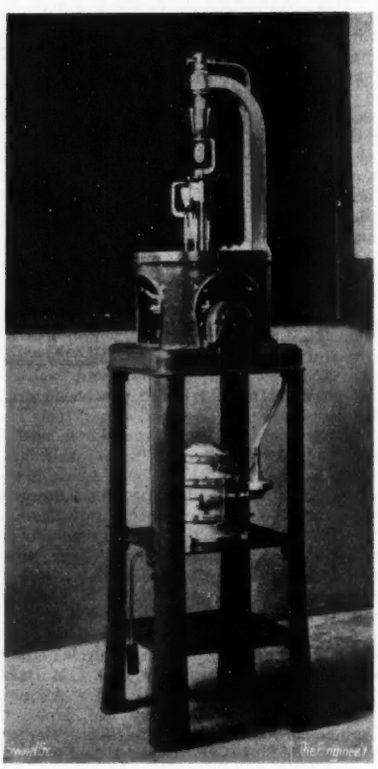

FIG. 7—AUTOMATIC MANTLE CHANGER

larger than the equivalent lens in the rotating group for producing similar beam intensity, the cost of maintenance is reduced. Furthermore, the intensity lost by the revolution of the lens (*i.e.*, the ratio of "fixed light" and "apparent" intensities) is reduced slightly. This principle, used in gas buoys for many years, is now having application to larger apparatus. Occulting characteristics (*i.e.*, those in which the period of light exceeds the period of eclipse) have, in the past, been obtained by installing "fixed" lenses incorporating steady lightsources, around which shutters were rotated or other obscuration devices employed. Such apparatus is now becoming obsolescent on account of the wastage of optical efficiency and the fact that occulting characteristics can be obtained more efficiently by the process of "flashing" the lightsource, described above. The "flashing" (officially termed "Nigrescing") characteristic is obtained both with

gas and electric lightsources. Cam operated mercury switches are usually employed to nigresce the electric lamps—the cams being driven by a small electric motor and reduction gear. An ingenious mechanism for imparting any light characteristic has recently been introduced by Chance-Londex, Ltd., which consumes a negligible amount of electricity. The gas flashers

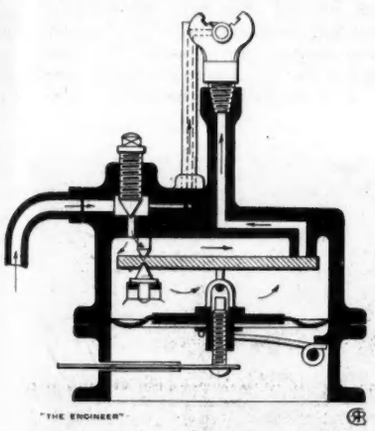

FIG. 8—A.G.A. GAS FLASHER

are ingenious also, and whilst there are a number of makes of flasher (*e.g.*, Chance, A.G.A., Pintsch, &c.) they employ a common principle of operation (see Fig. 8). This figure illustrates an acetylene flasher of A.G.A. type. Gas is admitted into the central chamber *viâ* an adjustable valve. Upon the chamber becoming filled with gas, the diaphragm is depressed slightly, which takes up the clearance between the loop and pin—shown in the figure—and pulls down the lever, thus admitting the gas to the acetylene burner, where it is ignited by a small pilot jet. The lever is magnetised so as to give "snap" action to the gas outlet. Upon the emission of the gas being completed, the whole process is repeated ad infinitum. It may be thought that this mechanism would lack precision in operation. On the contrary, the adjustment achieves most precise periods of flash and eclipse and as many flashes as 300 in a minute are possible with this apparatus. There are, of course, devices for obtaining groups of flashes, and the example given above is rudimentary.

Lanterns

Lighthouse lanterns are designed so as to give adequate protection to the optical apparatus whilst interfering as little as possible with the light emitted by it. A reduction factor of 0·8 is generally employed when computing lighthouse intensities to allow for losses due to "glazing," &c. (B.S.S. 942, 1941). Ventilation is another important factor, especially in the case of oil or gas lights, and special ventilators are provided in the lantern "murette" or base, and in the roof. Lanterns situated in exposed positions are usually built with helical type framing for strength, but on other types of light station the question of light obscuration is the primary consideration, and the type of framing is determined by the optical characteristics. Where the lens is of the "fixed" type, it is usual to erect a lantern having helical or inclined framing, so that the emitted beam will be obscured as little as possible and nowhere completely in one horizontal direction. Where revolving apparatus is employed, however, the vertical or inclined type of framing is to be preferred, mainly on account of cost, although in such cases vertical framing offers least obstruction to the light. In many Scottish light stations, the lantern murette has been constructed of masonry—the framing and roof being metallic. A gallery surrounds the lantern and additional galleries are sometimes constructed both within and without to facilitate cleaning and servicing. Lantern glass is usually of three-eighths to half-an-inch in thickness, depending upon the locality, and the panes are usually produced in specially curved or bent polished plate glass. Gutter and stove-piping is nearly always carried flush with the astragal framing to avoid obscuration of the emitted light. Polygonal lanterns have been adopted in the past, but the flat lantern panes have been known to cause "false flashes," which are produced when the optic flash is reflected off one flat pane through another.

It will have been seen that the lighthouse incorporates specialised equipment and is itself specialised in its construction.

In the next article, attention will be given to the subject of "Lightvessels."

(To be continued)

The Royal Show at Lincoln

No. III—*(Continued from page 30, July 11th)*

WE conclude in this article our description of some of the exhibits of agricultural machinery at the Royal Show.

William Foster and Co., Ltd.

Although combine-harvesters are being increasingly used in this country, there is still a great amount of work for the "barn-work" type of thresher, and the 54in medium-sized unit, shown by William Foster and Co., Ltd., of Lincoln, is a good example of the machines that are now being produced. The frames of this thresher are constructed of well-seasoned British oak, stiffened by means of two diagonal trussing irons on each side, and boarded with specially selected deal. The interior portion of the frame, where subject to excessive wear, is lined with sheet iron.

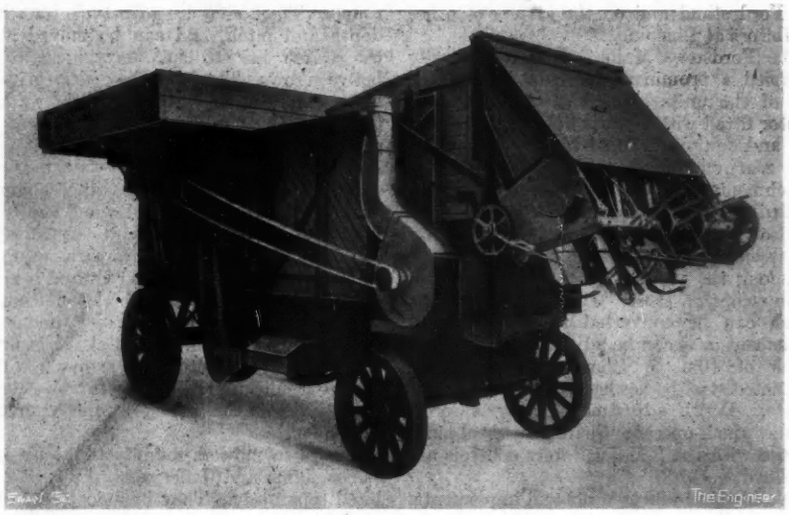

FIG. 20—THRESHER—FOSTER

The drum, which is equipped with rolled steel grooved beater beds and plates, has been designed to effect a clean threshing operation without injury to either grain or straw. Two longitudinal converging ribs, formed on the underside, run the whole length of the plate, the space between the ribs forming a dove-tailed groove into which fit the heads of the fastening-down bolts. The ribs, fitting against each side of a tapering groove in the bedplate, prevent the beater plate from breaking away from the beater bed, and the beater plate has no holes through it, so that the continuity of the threshing surface is unbroken by projecting bolt holes. An adjustable safety guard fitted over the drum mouth prevents any possibility of accident to the attendant.

Separation of the grain from the straw is effected by means of extra long double-crank shakers operated by two four-throw cranks, which are accurately balanced to minimise vibration, and the shakers themselves are fitted with ball bearings throughout. The corn elevator consists of a balata or leather belt fitted with pressed steel cups capable of taking up into the awner all the "first dressed" grain with which the machine can deal at maximum output, thus preventing the choking of the riddles of the first dressing shoe. After passing through the awner the grain is delivered on to the riddles of a second dressing shoe, but any grain overflowing from these riddles passes on to the first dressing shoe and is again returned to the second dressing apparatus. A tailings riddle receives the overflow from the second dresser riddles, extracting extraneous substances which would otherwise pass through the machine again, and delivers them into a bag or scuttle for removal. A final operation in the threshing "cycle" is the passage of the grain through an adjustable rotary corn screen, which removes small and defective grain as well as grading the corn as may be desired.

The engraving, Fig. 20, shows the thresher opened out for work, and it will be noted

that a straw trusser is built in to the after end. An additional labour-saving device is the blower, which deals collectively with chaff and cavings, blowing them through piping to a suitable distance from the machine.

FORD MOTOR COMPANY, LTD.

In recent months the Ford Motor Company, Ltd., Dagenham, has been co-operating with several other agricultural engineering concerns throughout the country in the production of a variety of implements specially adapted for use with the Fordson "Major" tractor. Many working demonstrations of

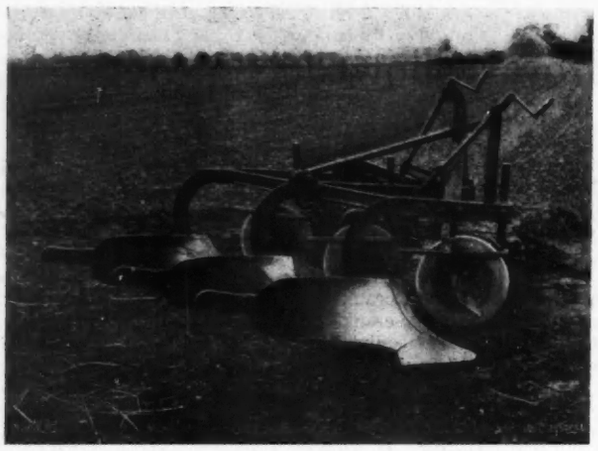

FIG. 21—MOUNTED PLOUGH—RANSOMES-FORD

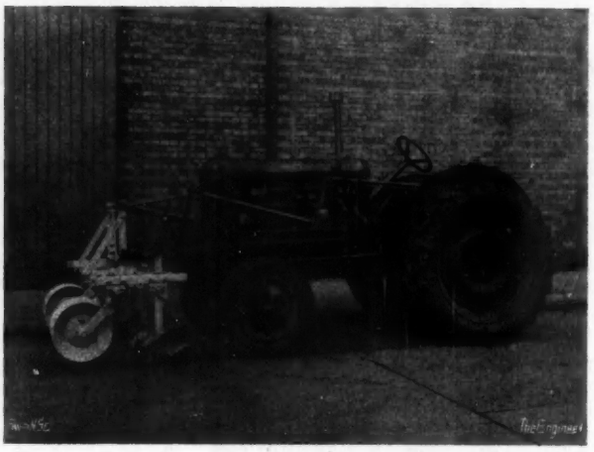

FIG. 22—FRONT TOOLBAR FRAME—RANSOMES-FORD

these implements have already been given at different agricultural centres, and a number of the implements was to be seen on the Ford stand and on the stands of other exhibitors at Lincoln.

The Fordson "Major" tractor naturally occupied a prominent place on this stand, one of the units shown being a row crop tractor fitted with electric lighting and starting, and equipped with hydraulic power lift and rear end toolbar, with steerage hoe attachment. It is of interest to note that towards the end of last month the 50,000th Fordson "Major" tractor was driven off the assembly lines at Dagenham.

Among the ploughs on the stand was an example of the "Elite" three-furrow plough, which can be converted to a two-furrow implement, and can be adjusted for a furrow width of 10in to 12in. Its semi-digger laminated steel bodies have replaceable share points. Depth adjustment is by a screw handle which operates the depth wheel, and, for use with the "Major," long controls are provided.

In addition to its tractors and implements, the company showed 5-cwt and 10-cwt vans and a horse-box, which is now being built in co-operation with Lambourn Garages.

RANSOMES, SIMS AND JEFFERIES, LTD.

Tractor ploughs and cultivators were the principal items exhibited by Ransomes, Sims and Jefferies, Ltd., Ipswich. There were also potato diggers, disc harrows, a flea beetle duster, an "Agro" atomiser sprayer, and front and rear toolbar frames.

Several of the Ransomes' implements are now being produced specially for use with the Fordson "Major" tractor, under an arrangement between the two firms. One of these implements is the three-furrow mounted plough illustrated in Fig. 21. It is of rigid frame construction and can be supplied for ploughing widths of 10in or 12in. A spanner-less three-point system of mounting on the tractor, with lever controls easily accessible from the driver's seat, ensures the simple operation of the plough, and there is adequate clearance to prevent clogging. Another feature is the disc type depth control wheel which is fitted with an adjustable scraper, and disc coulters, 16in in diameter, are provided for overcut and undercut work. This three-furrow plough, it may be mentioned, can be converted to a two-furrow implement.

The front toolbar frame, illustrated in Fig. 22, which has been evolved for use with the "Major" tractor, is claimed to be very suitable for splitting ridges in potato cultivation, and for this purpose it is fitted with three coverer bodies and a pair of rollers. The bodies are adjustable for width, depth and pitch, and can be moved along the frame bar to suit varying distances between rows. The rollers have deep gripping flanges and control the depth of the work, so that the frame follows the contours of the ground. To meet variations in width, the rollers are adjustable sideways on the spindles, or, alternatively, the complete attachments can be moved along the frame bar. The square frame bars can be set at distances of 11½in or 15½in apart, according to the amount of clearance required between bodies and rollers, and when the frame is lifted there is ample clearance under the bodies for travelling. The linkage is firmly attached to the tractor, and is operated from the hydraulic unit, but the frame is easily detached from the linkage by the removal of four pins.

The lawn mowers manufactured by Ransomes, Sims and Jefferies, Ltd., were exhibited separately. They include 12in to 16in models suitable for normal garden use, and some larger machines designed for parks and sports grounds.

DENING AND CO. (1937), LTD.

An addition to the "Somerset" range of implements shown by Dening and Co. (1937), Ltd., of Chard, is the "Somerspin" potato spinner, illustrated in Fig. 23. This tool has been specifically designed as a "unit principle" machine for tractors equipped with power take-off and hydraulic lift. It is simple and claimed to be efficient. An important design feature is the position of the share arm in relation to the rotor or spinner. Set behind the spinner, it cannot choke with haulm or trash, as the rotor spins clear all such matter.

The main frame is made from a 4in steel tube, which carries a 2½in alloy steel share arm, held by Mills pins and set screws. There is also a neat jack, which permits the machine to be stood in position whilst coupling the tractor. The share has a renewable chilled point. A six-armed star frame of ½in steel, bolted directly to a chain wheel drive sprocket, forms the basis of the spinner assembly. The arms of the star frame carry tine bracket castings, which have long shrouded bearings, with high-carbon steel tines clamped into grooves. To control the pitch of the tines there is a wheel working in conjunction with an eccentric. The share arm carries an adjustable depth control wheel.

The drive is taken from the tractor through a telescopic shaft, fitted with a slipping clutch, from which a Renold's duplex chain drives the rotor sprocket. This drive is enclosed, but the enclosure has a cover which

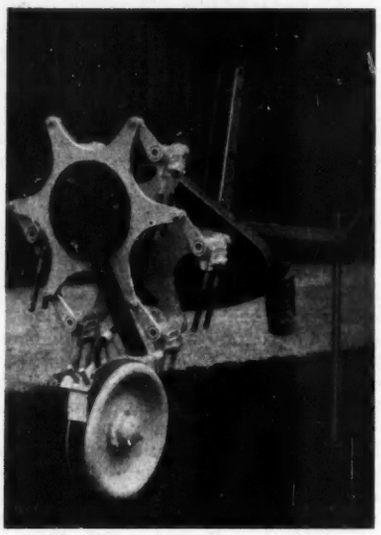

FIG. 23—"SOMERSPIN" POTATO SPINNER—DENING

is readily detachable. Grease gun lubrication nipples are provided for all bearings. The weight of the machine is 420 lb.

ALDERSLEY ENGINEERING COMPANY, LTD.

A grain dryer constructed by the Aldersley Engineering Company, Ltd., Tettenhall, Staffs, was entered in the "new implement" competition, and for it the makers were awarded a silver medal. A working model

was on show at Lincoln. In the drying compartment of this machine use is made of the accepted principle of inverted troughs or ducts, in which alternate rows of troughs are connected to inlet and outlet boxes so that the air travels from one row of troughs to the next through the grain. This principle, however, has been taken a step further in the "Aldersley" dryer by assembling the machine in small standard units, each one being turned 90 deg. on the one below so that the grain is turned and deflected in four directions instead of in the more customary two.

The units are made up in such a way that the grain compartment is surrounded by an air space, which is divided into two "L" shaped compartments by dividing plates in two diagonally opposite corners so that one compartment is an inlet air box and the opposite one is an exhaust air box. The inlet and outlet air boxes pass round the grain compartment in a spiral and the walls of the grain compartment are therefore surrounded by air over the whole surface.

The inverted troughs can be detached from the compartment and for cleaning purposes can be removed through the top of the dryer, so that it is not necessary to disturb the outside shell of the appliance, which may be permanently lagged to prevent loss of heat. The "Aldersley" dryer, it may be added, can be fitted with oil-fired furnace, steam or electric radiator, gas or coke furnace heating.

Our illustration, Fig. 24, shows a 4-ton per hour drying installation. In the foreground are the intake hoppers and elevators, the elevator on the right leading to the precleaner and that in the centre carrying wet grain from the precleaner to the dryer. The elevator on the left delivers dry grain to the sacking hopper. Other Aldersley exhibits were a 2-ton, two-wheeled, low-loading tipper, a gravity tipping trailer and a 450-gallon fuel or water tank trailer.

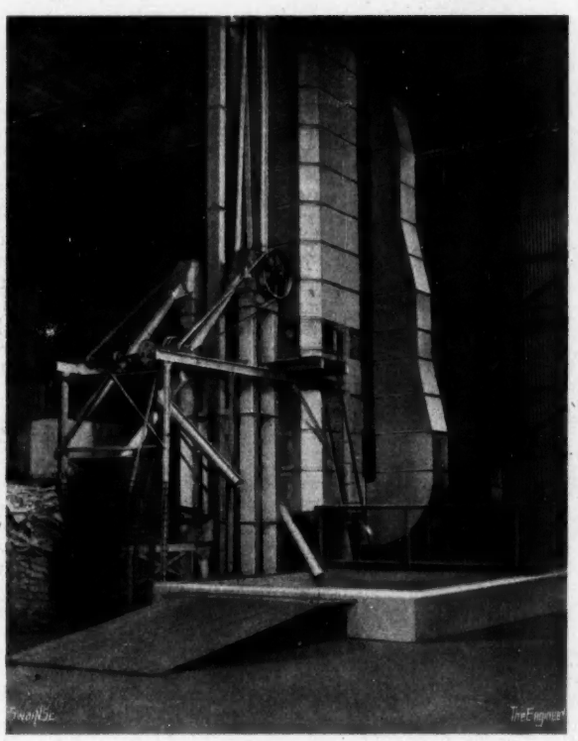

FIG. 24—GRAIN DRIER—ALDERSLEY

ASSOCIATED BRITISH OIL ENGINES, LTD.

From among the range of engines shown on the stand of Associated British Oil Engines, Ltd., we have chosen for illustration the first example of a new range of horizontal low-pressure oil engines of Petter-Fielding design, which is being built in single and twin-cylinder units in the Airdale Foundry of J. and H. McLaren, Ltd., of Leeds. The engine which was exhibited has a designed output of 40 b.h.p. when running at a speed of 500 r.p.m. at a twelve-hour rating. The cylinder bore is 8½in with a stroke of 13¾in. The design incorporates all those features which have been proved by satisfactory service in varied and arduous conditions of service in all parts of the world. Direct injection is used, with an open type combustion chamber, giving, it is claimed, easy starting with an economical fuel consumption and good combustion. The fuel consumption is 0·42 lb per b.h.p.-hour and the lubricating oil consumption 0·004 pint per b.h.p.-hour.

The gross weight of the engine is 1·89 tons with the standard fly-wheel and 2·3 tons with a heavy fly-wheel. The bed-plate is strongly constructed and has large whitemetalled crankshaft bearings. A machined "Meehanite" casting is used for the crankshaft, which is furnished with balance weights and carries a solid-flange coupling, to which the fly-wheel is bolted. The connecting-rod is of "H" section and has a large big-end bearing of the marine type. A compression plate is mounted between the bearing and the palm end of the rod. With the standard fly-wheel the cyclic variation is 1/35, and with the heavy fly-wheel it is 1/70. A two-weight governor is gear driven and is pressure lubricated. The speed range of the engine is plus 5 per cent to minus 10 per cent of the normal running speed, and the design is such as to control the speed of the engine within the limits specified by the current British Standards Specification. The engine is lubricated by a plunger cam-operated pump, which draws oil from the sump in the base-plate and delivers it through an Auto Klean filter to the bearings. Provision is made for tank cooling on the thermo-siphon principle or by means of through circulation.

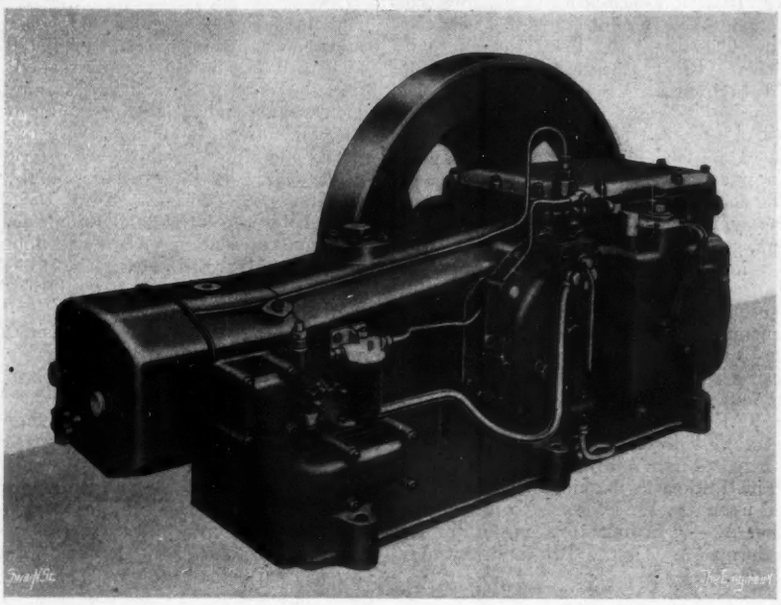

FIG. 25—40 B.H.P. HORIZONTAL OIL ENGINE—PETTER-FIELDING

Mechanised Coal Loaders in Canada

CAPE Breton's big coal operators, whose high-cost product has had to meet competition from low-priced United States fuels on the central Canadian market, are about to take a leaf from the American book and try completely mechanised mining in Nova Scotia's undersea pits. Although cutting, drilling and hauling coal in Nova Scotia mines has long been done by machinery, only one small company has tried successfully to mechanise the job of loading coal underground. In the larger pits the key worker still is the man who shovels the coal from the mining face into boxes or conveyors. The Dominion Steel and Coal Company officials say complete mechanisation is not likely to come suddenly. It will be at least five years before any appreciable number of men will be displaced. Meanwhile, a few machines will be installed to see what they can do in the dipping seams of the underground workings. The company's engineers have hesitated to predict what the new machines will do before they go into action, but they have already enabled United States mines to raise their production to 7 tons a man-day. The 1939 level in Nova Scotia mines was 2·4 tons. It has since fallen to 1·5 tons per man-shift.

Powder Metallurgy

No. I

ON Wednesday and Thursday, June 18 and 19, 1947, a meeting, organised by the Iron and Steel Institute, was held in the Lecture Theatre of the Institution of Civil Engineers, Great George Street, London, S.W.1, to discuss "A Symposium on Powder Metallurgy"—No. 38 in the Special Report Series of the Iron and Steel Institute. A small exhibition of powder metallurgy products was displayed in an adjacent room during the meeting.

The symposium consisted of twenty-eight papers, grouped in six sections, the grouped papers in each section being presented by a *rapporteur* and discussed together.

The proceedings opened on Wednesday afternoon, June 18th, when the chair was taken by Mr. D. A. Oliver (Director of Research, the B.S.A. Group of Companies), in the unavoidable absence of Dr. C. H. Desch, F.R.S. (President of the Iron and Steel Institute). The chairman, after indicating that help had been received from a number of other institutions in planning the symposium, called upon Dr. W. D. Jones to present:—Section A.—"Introductory": (1) "Powder Metallurgy in Great Britain," by W. D. Jones.

Powder Metallurgy in Great Britain

Dr. W. D. Jones (London), in a historical introduction, referred to the establishment by Bessemer and Wollaston of the basic techniques of powder metallurgy as practised to-day.

Sir Henry Bessemer, said Dr. Jones, was the founder of the manufacture of brass powder for use in so-called gold or bronze paints. He started production in Baxter House, St. Pancras, in 1843, and held almost a monopoly of the gold powder business until he ceased production about 1880, after which there was no evidence that further powders of this type were made in this country until 1907.

Very little was known about how Bessemer actually made his powders. Apparently there are no working drawings in existence, and it was not even known exactly why or exactly when Bessemer gave up making these powders.

Bessemer established the necessity, amongst other things, of employing lubricants to prevent welding, the principles of burnishing or polishing, air classification, the use of bag filters and the employment of the microscope. He made use of heat-tinting of metal powders and chemical colouring or plating, and there was some reason to believe that he experimented with the atomisation of molten metals.

The founders of the English firm of Johnson, Matthey and Co. were manufacturing malleable platinum by powder metallurgy as early as 1800, under the direction of W. H. Wollaston. Although earlier workers had manipulated platinum powder, Wollaston must be credited as the founder of the first fully worked out industrial process. His work was very remarkable. He described, for example, the use of finely divided reactive powder by precipitation from dilute solutions, the dangers of work-hardening or burnishing, the use of sedimentation, the pressing of wet powder in lubricated dies, the principles of slow drying and heating for the removal of adsorbed gases or films and the use of hot-forging at the highest possible temperatures.

Wollaston's process was believed substantially to have passed out of use in 1859 or 1860.

The manufacture of flake powders in this country was apparently restarted in 1907 by the British Aluminium Company at Milton, in Staffordshire, with the use of stamp mills which were brought from Nuremberg by Dr. Seligman. Since then flake powders have been in continuous manufacture in Britain by one organisation or another, notably by the Aluminium Corporation at Dalgarrog before 1914, and by Metal Powders, Ltd., a company representing Vickers and Johnson, Matthey and Co., Ltd., during the 1914–1918 war. The ball mill was apparently used for the first time for the manufacture of flake powders in 1932 by the English Metal Powder Company.

The name of Johnson, Matthey occurred several times in powder metallurgy. It is interesting that their subsidiary company, Metal Powders, Ltd., or its sub-contractors, during the 1914–1918 war, were the first to manufacture magnesium powder in Britain.

With regard to the subject of atomised powders, he did not know when they were first made commercially in Great Britain. Low melting point metals, such as tin and lead, were produced in this way before 1914, and the manufacture of atomised copper probably began about 1925. There was a similar lack of information, as far as he was concerned, about electrolytically produced powders, but full commercial production of these materials was under way in 1939. Of course, during the recent war vast quantities of milled powders of aluminium, magnesium and aluminium-magnesium alloys were manufactured for explosive and incendiary uses.

(Dr. W. D. Jones then read the remainder of the paper as printed.)

Preparation, Properties and Testing of Metal Powders

Dr. L. Northcott (Armament Research Department, Woolwich) then introduced the papers of:—

Section B.—"The Preparation, Properties and Testing of Metal Powders": (2) "The Manufacture of Iron Powders by Electrodeposition," by G. E. Gardam; (3) "The Production of Ferrous and Non-Ferrous Metal Powders," by G. L. Miller; (4) "Some Properties of Engineering Iron Powders," by C. J. Leadbeater, L. Northcott and F. Hargreaves; (5) "Flake Metal Powders: Their Application, Manufacture and Testing Methods," by H. Meyersberg, after which Sections A and B were discussed together.

Dr. Northcott said that the major part of the paper by Dr. Gardam on the "Production of Iron Powder by Electrodeposition" was taken up with a determination of the experimental conditions to provide a loose, powdery type of deposit, and with a consideration of the difficulties which occurred in the case of iron, owing to its reactivity in the presence of air and water, the rapid hydrolysis of ferrous and ferric salts, and the need for including insoluble anodes in the circuit. The author then described briefly a small experimental pilot plant consisting of a rubber-lined tank, fitted with anodes, half of which were made of mild steel and half of lead. The cathodes were nickel-plated brass tubes and the powder was scraped from them every two hours. The powder, as produced, was not very suitable for compacting, owing to its oxygen content, but it was improved by annealing in hydrogen at a temperature of about 700 deg. Cent. for one hour. Brief comment was made on two other electrolytic methods of iron powder production, *viz.*, the preparation and grinding of hard, brittle flake iron and the electrolytic reduction of ferrous hydroxide.

The paper by Dr. Miller, on the "Production of Ferrous and Non-Ferrous Metal Powders," gave a summary of the different methods of preparation of metal powders which were available. The author classified them into eleven groups, the eleventh being a variety of miscellaneous methods. The first one was milling, and the author referred to the various types of mills, such as ball mills, disc crushers, and so on. The milling process for making powders was of importance, not only because it was an adjunct to other methods of breaking up metals, but because it had been used in Germany during the war to a very considerable extent for making large quantities of iron powders. The second group was machining, which was used to a comparatively small extent in this country. The next was atomisation, which in effect could be applied to all metals or alloys which could be melted by running the molten metal through a nozzle or jet; this method was developed considerably in Germany during the war for the manufacture of iron powders. The next two groups were granulation and graining, and the sixth was the reduction of metallic oxides. This had an advantage in that the metallic oxides could be readily crushed to a small size, and the process resulted in a very fine metallic powder 1μ or even smaller in size. The next process was the reduction of metallic salts. There were certain metals whose oxides were not readily reduced, and the author gave the instance of the reduction of potassium tantalum fluoride by heating it with metallic sodium to give metallic tantalum. The next process was the electrolytic process, which had been discussed already to some extent in Dr. Gardam's paper, making either a soft powder type of deposit or a brittle one, which was subsequently powdered. The next two processes were the carbonyl process and the hydride process, which was particularly used for metals that form hydrides. In the eleventh group the author included sundry methods which he considered of insufficient importance to warrant a separate classification, such as chemical precipitation.

The paper on "Some Properties of Engineering Iron Powders," by investigators from the Armament Research Department, was in four parts. Part I dealt with the methods of testing the various properties. In Part II of the paper the authors used these methods for examining twenty-eight different iron powders, half of them from American sources and half from British. Most of the powders were either electrolytic or oxide-reduced, but three other types of powders—carbonyl, abrasion and chloride-reduced—were also included. The properties of sintered compacts prepared by similar pressing and sintering technique were described in Part III. The test compacts were prepared from each powder, after compacting at 30 ton per square inch and sintering for 1 hour at 1050 deg. Cent. in a hydrogen atmosphere. Part IV of the paper contained a discussion of all the results, and included a correlation of the different properties, with a view to determining which were of particular significance. The paper had a useful Appendix by Dr. Lea, of the Building Research Station, on a modification of the air

permeability method of determining the specific surface of iron powders.

Dr. Meyersberg, in his paper on flake metal powders, started with a comparison between flake powders and other powders used in powder metallurgy, the essential property of flake powders being that the individual particles were in the form of flakes having a ratio of length to thickness of between 60 to 1 and 100 to 1. The author then discussed the application and use of flake powders. They were of importance in the paint, plastic, printing and paper processing industries. He then dealt with the methods of producing flake metal powders, the first being the stamping process. In order to obtain a suitable flatness of the powder, *i.e.*, a flake, it was necessary to subject the raw material, in the form of splashings, to pressure or impact, and stamp mills were used for that purpose. The author briefly traced the development of stamp mills from the early six-rammer open type to the modern variety. In order to obtain suitable flattening, in the first instance, it was necessary to use fairly heavy stamps, but, in order to avoid excessive breaking up of the powder, later stamping had to be done with stamps of lighter weight. Normally three types were used, heavy, medium and light. The author illustrated examples of these, an 18-rammer stamp in the heavy type and a 28-rammer stamp in the light variety. After stamping it was necessary to polish the powders, and that was done in a polishing drum, which consisted of a rotating drum with brushes inside, the powder with a small quantity of lubricant being fed into the drum and either the brushes or the drum or both being rotated, so that the individual flakes were suitably polished. One disadvantage of the stamp mill process was the lack of control of the oxidation, which in the case of aluminium powders in particular was important, as it gave rise to severe explosion risk. (The principal metals used for flake powders were copper, bronze and aluminium, copper and bronze principally for decorative effect and aluminium for its resistance to corrosion and certain other properties.) In order to avoid this explosion risk, the ball-mill process was used. The machine was a modified ball mill, which was described by Dr. Meyersberg as a flattening drum. The drum was fitted with horizontal slats which carried the balls and the raw material about three-quarters of the way up the drum, then they fell and the powder was flattened. A controlled atmosphere was used not free from oxygen, since there was a certain degree of oxidation in the case of aluminium (oxygen contents of the order of 3 to 5 per cent were required); and by a sufficiently high velocity in the atmosphere, the fines could be blown through the flattening drum into a cyclone and from there into the polishing drum.

Discussion

Dr. J. C. Chaston (Johnson, Matthey and Co., Ltd., London), in opening the discussion, said that Dr. Jones's paper reviewed most adequately all that was known about the history of powder metallurgy in this country; he did not think that anything of importance was omitted. There was, however, one very minor point which he might mention. Dr. Jones said that the manufacture of platinum by powder metallurgy went out of use in 1859 or 1860; but the manufacture of platinum by the Wollaston process had, in fact, been continued until the present day. Not all platinum had been made in that way; but a certain proportion had been made in this country by the Wollaston process continuously from its inception until the present day and was still being made in that way. As far as he knew, the equipment and the methods used had changed very little. Incidentally, he might add that certain platinum alloys were made during the war by powder metallurgy, and there were patents relating to that.

Dr. Chaston thought that there was one minor point which Dr. Gardam had overlooked, and which should be mentioned. The manufacture of iron powder by milling—that is, by first depositing a brittle sheet and then grating it up to a powder in a ball mill—had been practised since about 1921. There was a paper, to which he thought some reference ought to be made, by B. Speed and G. W. Elmen, published in the "Transactions" of the American Institute of Electrical Engineers in 1921, in which were fully described the methods employed by the Western Electric Company in making iron powder used in the manufacture of loading coils.

Dr. Miller's paper was, in his opinion, completely adequate. He did not think that any major method had been omitted, but he would have welcomed more detailed information of the methods used. In the next paper, by members of the Armament Research Department, details of the properties of an enormous number of powders were given, and it would have been useful to be able to correlate those with the methods by which the powders had been made. He knew that he was asking for something which could not be done, as none of the people who supplied iron powders would say how they made them. If, as a result of this symposium, the manufacturers and the testing people could get together and give us information about how the powders were made, as well as about their properties, it would do much to help towards a better understanding of powder metallurgy. Details of the hæmatite iron powders made in Germany would have added to the value of the paper.

Dr. W. D. Jones (London) said that he regarded the paper by Dr. Northcott, Mr. Leadbeater and Mr. Hargreaves as one of the most important that had been published on metal powders. It showed the value of standardising testing procedure for metal powders and the need for a much closer examination of the various methods than there had been in the past. Various authors used various methods for testing their powders, with different results, and, in fact, they often used different words for the same thing. The American Society for Testing Materials had formed a sub-committee, which was attempting to produce an agreed glossary of terms used in powder metallurgy, and was going on to standardise powder metallurgy testing methods. He thought that this was one of the matters to which the Iron and Steel Institute might give attention in the future.

Although the paper consisted very largely of statistical results and generalisations, he was interested in one particular detail. Iron powder No. 25 produced compacts with the highest tensile strength, elongation and hardness; it was one of the highest in impurity content generally and it had the highest oxygen content—1·18 per cent—which was higher than the oxygen content of Dr. Gardam's electrolytic-iron powder, which was stated to be practically useless because the oxygen content was so high. That was one of the contradictions in this symposium. Moreover, the authors said that any treatment they gave to this powder, including the reduction of that oxygen content, made it worse instead of better, and he would be glad if the authors when replying would tell them why that was so.

Dr. Maurice Cook (Imperial Chemical Industries, Ltd., Metals Division, Birmingham) said that in the important and very interesting paper by Mr. Leadbeater, Dr. Northcott and Mr. Hargreaves considerable stress was, rightly, laid on the flow test, and the work done so far would, he thought, help in the formulation and establishment of a standard flow test. It might not be necessary to make it so elaborate as was suggested in the paper. In applications of this kind the powder must have very good flow properties, and therefore there was no serious interest in testing powders which did not flow at all well. Dr. Cook added that he would like to register a very mild protest in connection with terminology. He thought it was customary to talk about the diameter of an orifice or tube rather than the radius, as Dr. Northcott and his colleagues had done. He also deprecated the use of the term "onion" structure in Dr. Pfeil's very informative and interesting contribution on carbonyl-iron powder in Section C of the symposium. He thought they might use the term "concentric structure" and leave the onion, where it properly belonged, in the greengrocer's shop and the kitchen.

Dr. J. C. Chaston (Johnson, Matthey and Co., Ltd., London) referred to the question of taking photographs of metal powders. He had obtained the best results by using a microscope in which he could put the powder dry on a glass slide, distribute it by gentle tapping and illuminate it by a ring illuminator placed below the microscope slide. A combination of vertical and side illumination could thus be obtained which gave a very fine appearance of depth. The photographs which were reproduced in Dr. Northcott's paper were very good, but he thought they would have been very much better if they had had a greater depth of focus.

Dr. W. F. Chubb (London) said that he was particularly interested in the paper by Dr. Miller, because they had collaborated at Zürich in producing tungsten powder and also because, in 1930, at the Battersea Polytechnic, he had experimented with a purely chemical method of producing iron powder. If ordinary iron were dissolved to produce an acetate solution, it could be recovered in a very finely divided form by neutralising that solution very carefully and adding hydrazine. He had never seen that method described anywhere and had not published anything on the subject himself. He thought the method might well be further investigated, because it offered a possibility of making iron powders relatively cheaply and in very large quantities.

Dr. L. Northcott (Armament Research Department, Woolwich), in commenting on Dr. Miller's paper, said that he regarded the fifth process, graining, as sufficiently unimportant to be included in the miscellaneous section at the end of the paper, whereas he would prefer that the production of zinc powder should be given a somewhat higher status than was implied by classification under the heading "Miscellaneous."

Under the heading "Reduction of Metallic Salts," Dr. Miller said: "The final product is a spongy material, which can be crumbled to produce any size of powder required, down to the low μ range; this is a particularly useful feature when free-flowing powders are required." That appeared to indicate that by getting down to a low μ range one increased the flowability. He would like to ask Dr. Miller whether that was so. His own experience had been that free-flowing powders were not generally of the low μ range.

(To be continued)

A Swashplate Hydraulic Pump

A NEW swashplate hydraulic pump which has been designed by Mr. T. E. Beacham, is now being manufactured by Oswalds and Ridgeway, Ltd., Sleaford Works, Strutton Ground, London, S.W.1. It has been developed to form a simple, compact and self-contained source of hydraulic power with a wide range of application. Units are being made in a series of standard sizes having working pressures from 1500 lb to 6000 lb per square inch, and are suitable for direct coupling to electric motors or internal combustion engines.

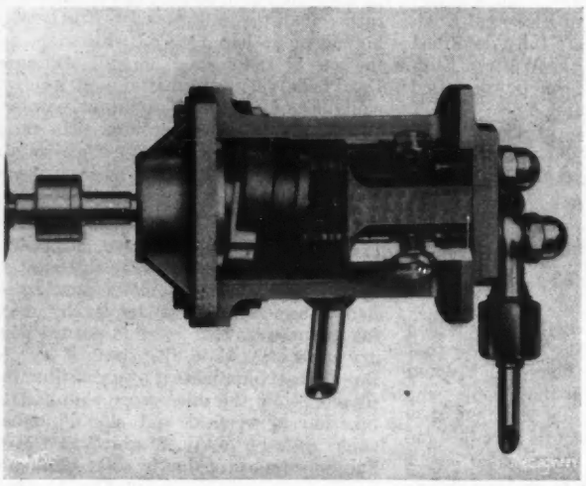

FIG. 1—SECTIONAL MODEL OF PUMP

The mechanism of the pump contains neither connecting rods, slipper, nor universal joints, the reciprocation of the plungers being obtained by direct contact between them and a single swashplate. The relative motion at contact between swashplate and plungers is a rolling one without friction or wear.

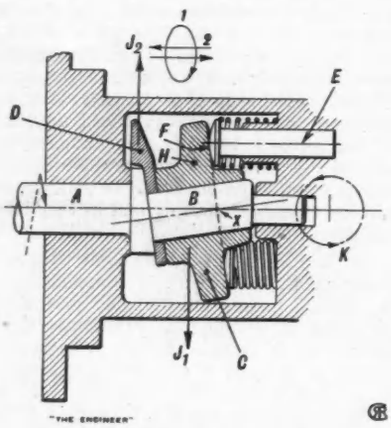

FIG. 2—DIAGRAM OF SWASHPLATE MECHANISM

ACTION OF PUMP

The action of the mechanism can be followed from the photograph of the sectional model reproduced in Fig. 1 and the diagram Fig. 2, which shows the bare elements of the mechanism. On the driving shaft A is formed the conic crank B supporting the swashplate C, which is free to rotate on the crank. A balance weight D is rigidly fastened to the shaft. The face of the swashplate lies in a plane which passes through X, the point of intersection of the shaft and the crank axes. Pistons E have spherical ends which bear against the swashplate face, springs being provided to keep the pistons in contact during the suction stroke.

Possibly the easiest method of explaining the relative motion between the swashplate and the pistons is to assume that the cylinders rotate and the shaft is stationary instead of *vice versa*, the relative movement, of course, being the same in both cases. Assuming this, Fig. 4 shows the end view of the head of a single piston at eight different points in one revolution. The top position is at the outer dead centre position of the piston and point F (see also Fig. 2) represents that point on the swashplate surface intersected by the piston axis when in this position. The contact point (indicated by the small hatched circle) is vertically below the centre at a radius depending on the spherical radius of the piston end. Now assume that the cylinders rotate in a clockwise direction. The friction between the pistons and swashplate drag the latter round in unison with the movement of the cylinders; the piston axis moves along the chain dotted circle while at the same time the point O moves in the path shown by the dotted ellipse, and the relative movement between them at any point is the horizontal distance between circle and ellipse (*i.e.*, the distance G). Now, under the conditions assumed the inclination of the swashplate remains fixed and the contact point remains vertically beneath the piston centre. Thus the relative movement G is always at right angles to the radius at the contact and instead of causing sliding, it merely rotates the piston in its cylinder through the angle α. Thus it follows that the movement between the two surfaces at the point of contact is a slight angular oscillation, the displacement from the starting position being represented by the angle α.

While this oscillation is taking place, the contact point is moving steadily around the piston head through the angle γ, which is approximately equal to the angle turned by the crank, *i.e.*, θ. The oscillation is small enough compared with the movement γ to be absorbed in the elastic stretch and compression of the material, the action being similar to that which takes place in a ball bearing with curved tracks, and the contact thus is substantially equivalent to pure rolling without friction or wear.

In addition to the rotary oscillation of the piston in its cylinder there is a small continuous rotation to compensate for the small difference in length between the contact circumference on the spherical piston head and the corresponding contact line on the flat swashplate surface. To accommodate this a slight relative rotation between piston and spring takes place at the end of each stroke where the spring pressure is weakest.

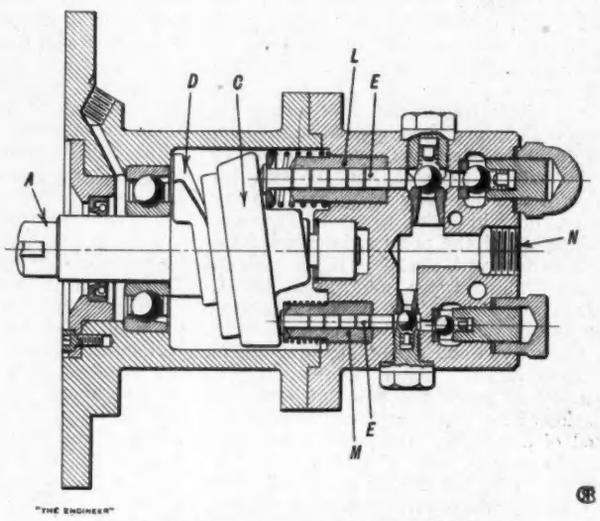

FIG. 3—SECTION THROUGH SWASHPLATE PUMP

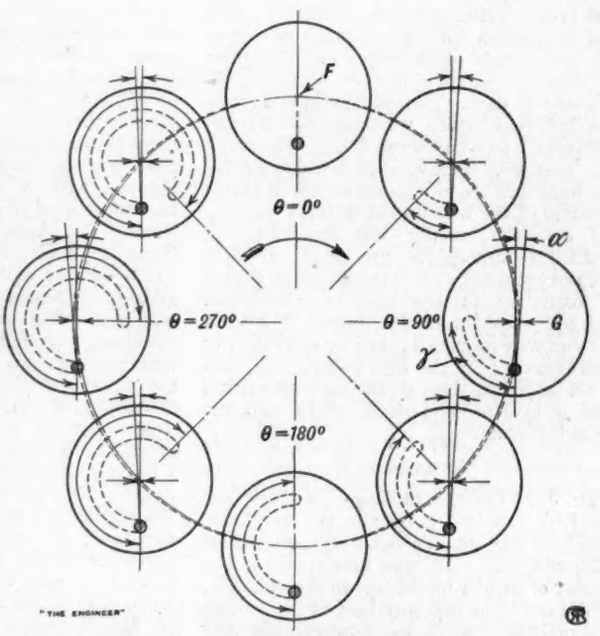

FIG. 4—DIAGRAM OF RELATIVE MOTION BETWEEN PISTON AND SWASHPLATE

BALANCE

Another important consideration in the design

of the mechanism is the dynamic balance. The swashplate and its associated parts are moved by the conic crank but prevented from rotating bodily with it by the contact with the pistons. The motion of any particular particle H (Fig. 2) can be divided into two components, one a rotation in a plane at right

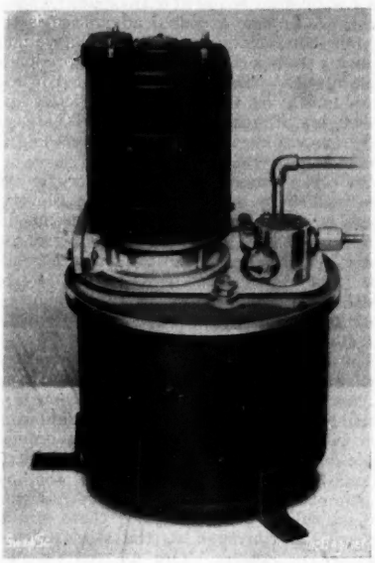

FIG. 5—PUMP AND TANK UNIT

angles to the shaft and second a reciprocation in a direction parallel to the shaft.

Now the sum total of the centrifugal forces due to the rotation of the individual particles will add up to a resultant centrifugal force J_1, while the inertia forces due to the reciprocation of the same particles together with the inertia loads due to the motion of the pistons and springs will add up to a couple K. The resultant centrifugal force J_1, and the resultant couple K will both be in the plane of the shaft and crank axes and hence can be balanced by the centrifugal force J_2 exerted by a single balance weight. Force J_2 is made equal in amount to J_1 but displaced from it by a distance exactly sufficient to create a torque equal and opposite to K.

PUMP MECHANISM

In Fig. 3 is reproduced a cross section through a standard pump, with six cylinders having three major cylinders L, and three minor M. All six are connected to a common inlet N but each group is connected to separate outlets (not visible in this view). The two outlets are connected to a special valve having four operating positions. In the first position all the cylinders are by-passed to the tank, in the second, the major cylinders only, and in the third, the minor cylinders only are by-passed, and in the fourth position both sets of cylinders are in action. The arrangement, therefore, provides three different capacities and an off position with the one pump.

The cylinders are screwed in to the pumps and a range of different sizes are available for each type of pump. Ball delivery and suction valves are used, but in more recent designs of pumps inlet valves of the mushroom type have been adopted.

Similar pumps are being manufactured in a range of sizes both as single or duplex pumps. Another type with one set of much larger pistons is also being made for use as a combined high and low pressure pump.

The pumps are normally suitable for speeds up to 1500 r.p.m., and as we were able to see at a recent demonstration, are quiet and free from pulsations. Friction and leakage losses are extremely low, an overall efficiency of 90 per cent to 95 per cent being claimed over a wide range of conditions.

The dynamic balance and freedom from vibration, as a rule, make it unnecessary to bolt the pump to a rigid foundation. In many cases it is convenient to immerse the pump in its oil reservoir, as shown in Fig. 5. The horizontal layout shown in Fig. 6 can be used where a low overall height is desirable. Both arrangements as illustrated include filters and relief valves and in the latter case a reversing control valve is mounted on the side of the tank.

The units described have been designed to form a cheap, convenient and self-contained source of hydraulic power not only for presses and other types of hydraulically operated machinery but also for numerous new applications where the convenience and controllability of hydraulic operation is particularly desirable.

One self-contained unit for operating a 200-ton testing machine is arranged to bolt to the column of the machine. In this case three sets of cylinders are provided to give seven different outputs in arithmetical progression. While the mechanism is particularly adapted to the purpose for which it has been described, it is considered that it may have advantages for other purposes such as hydraulic motors, small air compressors, and refrigerating machines.

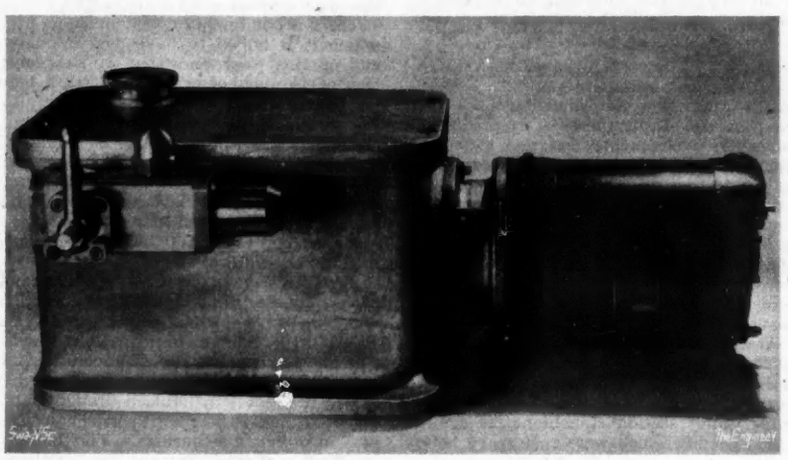

FIG. 6—HORIZONTAL PUMP AND TANK UNIT

The Chemical Society Centenary Celebrations

THE centenary celebrations of the Chemical Society, which was founded in 1841, and received its first Royal Charter in 1848, took place in London this week from July 14th to 17th. It is the oldest Chemical Society in the world and since 1857 it has had its headquarters in Burlington House, London, in close association with a number of other learned societies.

The main function of the Society is to foster original research in chemistry and to facilitate the discussion and dissemination of new knowledge in all branches of the science. Fellowship of the Society is open to men and women of all nationalities.

From a small beginning, the Chemical Society has had a spectacular growth and the fame of the work of its members has been recognised all over the world. One hundred years ago it numbered only twenty-five members; to-day, its membership is over 7000. Among the distinguished names which have appeared in its membership lists are Michael Faraday, pioneer of organic chemistry; Sir William Perkin, whose discovery of mauve from coal led to the modern dyes industry and Dewar, who gave us the idea of the vacuum flask.

Owing to the war, the Society was unable to hold the celebration of its hundredth birthday in 1941; it was therefore arranged to take place on the above-mentioned dates. On this occasion the Society was host to delegates from twenty-five nations, and in addition there were 1500 British delegates. There was a three-days' programme of celebrations, followed by the XIth International Congress for Pure and Applied Chemistry.

The Faraday Lecture was given by Professor Sir Robert Robinson, the distinguished organic chemist and President of the Royal Society. He was presented with a commemorative medal.

Features of the programme were the Centenary Dinner, at which the British Prime Minister and eminent foreign men of science were guests, receptions and dances at the Dorchester and Grosvenor House Hotels, a luncheon to overseas visitors given by the British Government, and a garden party for the Fellows of the Society, which was also given by the Government.

The Chemical Society's Centenary Exhibition, held at the Science Museum, South Kensington, illustrates the history and achievements of British Chemistry. Much original apparatus used by famous pioneers is on view, most of it for the first time. The exhibition will stay open till September 13, 1947.

Bus Body Production in South Africa

OUTSTANDING examples of the prevailing tendency for manufacturers in Britain to encourage or take part in the production of British engineering designs in the Union of South Africa are given by two recent developments in the bus body building industry. The first of these is that whereby British Mining Supplies, Ltd., Cleveland, has come to an arrangement with Park Royal Vehicles, Ltd. for the production of "Park Royal-B.M.S." all-metal bus bodies. B.M.S. has now changed over its bus body production to the designs of its associates. Special machines have been installed for the production of bus body pressings. Unworked material is purchased partly from overseas, but in the main from within the Union. A considerable amount of skilled operations are carried out in the works transforming these materials, including leather, aluminium, sheets, steel, timber and Rexine, into bus body components by pressing, welding or sewing the material, thus converting them into mouldings, internal upholstered fittings and other items. The other example is the establishment at Port Elizabeth of a bus body factory, registered under the name of Bus Bodies (S.A.), Ltd., by the Metropolitan Cammell Carriage and Wagon Company, Ltd. The factory, built on a site of fourteen acres, is estimated to cost at least £80,000. The company's capital of £150,000 has been fully subscribed in South Africa. Although the company will undoubtedly concentrate on assembly work for some time to come, it is the intention of the executives that the Port Elizabeth factory should eventually handle the complete manufacture of Metropolitan Cammell bus bodies.

Modernisation of the Iron and Steel Industry

No. III (*Continued from page 31, July 11th*)

Richard Johnson and Nephew, Ltd.

RECONSTRUCTION of Richard Johnson and Nephew's continuous rod mill, which it is hoped to complete by this autumn, is to cost £200,000. The present developments are thorough-going and involve alteration or replacement at every stage throughout the mill. As ever, it has been imperative that current production should not be impeded and only the very last stage (the installation of new roughing stands and alterations to the preheating furnace) will interrupt output.

Already in operation are a new Woods gas-producing machine with an input of about 2½ tons per hour of coal and the four semi-finishing and six finishing stands of the new layout with coilers and conveyor mechanism for cooling. Through the new stands one string is being put from the present eight-stand roughing mill, giving a speed of about 2900ft per minute, against the ultimate speed of 4000ft per minute, which will be achieved when the installation is completed and two strings are running through. The mill output is then expected to be in the neighbourhood of 2000 tons per week, about double its previous capacity.

Installation of New Rod Mill.—The new installation is a straight-through mill, replacing the old mill with two separate finishing trains, one on each side of the roughing train, running parallel and in the reverse direction to it. It is because of this that it has been possible to install the new semi-finishing and finishing train without disturbing the present arrangements. The new roughing and intermediate stands, however, cannot be erected before the present stands are removed. There will be a total of nineteen stands: Nos. 0 to 6 roughing; 7 and 8 intermediate; 9 to 12 semi-finishing, and the remainder finishing. Stands 0 to 8 will have 13in diameter rolls, the remainder 10in.

The drives will be arranged so that power will come from two motor generator sets, normally running in parallel, but capable of being split. The roll stands will have the following motors:—

Stands		Motors
0	Roughing	1×125 h.p.
1 to 4	,, ...	1×1,000 h.p.
5 and 6	,, ...	1×460 h.p.
7 and 8	Intermediate ...	1×460 h.p.
9 to 12	Semi-finishing ...	Each stand 1×230 h.p.
13 to 18	Finishing	1×800 h.p.

There will thus be nine motors in all, each of 440V d.c. variable speed.

The motors on the mill which is being replaced comprise a 750 h.p., 3-phase motor on each of the two finishing trains and a 2750 h.p., 3-phase motor on the roughing stand, all of 6500V. The opportunity is being taken to build a new motor generator house and to tidy up the layout of the drives.

The new driving arrangements with the "splittable" motor generators and individual drives on the semi-finishing stands will enable a high degree of flexibility to be maintained in the rolling of thicker sizes. A pair of Garrett coilers is being installed in a position to receive rod from No. 10 or 12 stands, passing the coils back into the normal flow beyond the four Edenborn coilers, which are installed at the end of the finishing train. The finishing train, therefore, can be by-passed in the rolling of sizes between, say, 5/O G and ¼in diameter, and the splitting of the motor generator sets will enable a greater relative speed range to be maintained in these circumstances.

An oval/round draft is used on the rolls, which are changed by means of removable housings and an overhead crane. Timken roller bearings are used throughout and there is Farval lubrication on the roll stands. The coilers are air-cooled and are lubricated by separately driven pumps.

The handling arrangements beyond the coilers comprise a gravity slat conveyor running at right angles to the direction of the mill and leading through a pneumatically operated gate to an overhead hook conveyor, running the length of the shop and back to the loading dock, whence the coils are transported to the adjacent wire works or elsewhere.

It is intended to improve the reheating furnace when the new roughing stands are installed, and preliminary work has already begun. The furnace is to be slightly enlarged and an electric push feed from the back is to be substituted for the present hydraulic push feed from the side. Live roller feed is also to be installed as far as the furnace.

To recapitulate: output capacity of the continuous rod mill is to be approximately doubled by the installation of a new, nineteen-stand, straight through, two-strand continuous mill. The semi-finishing and finishing stands (Nos. 9 to 18) are already installed and are partially in operation, receiving one strand from the present finishing train. Output is maintained for the time being, also by the use of one of the old finishing trains until the new installation is complete. The new coilers and hook conveyors are installed and in use, as is a new gas machine for the re-heating furnace.

When it can be done with the least interference with production, the present roughing mill will be taken out and the new roughing mill (stands 0 to 6) and intermediate mill (stands 7 and 8) will be put in, while, at the same time, certain alterations will be made to the furnace arrangements.

After the completion of the rod mill replacement, there is in prospect considerable reorganisation of the wire mill and an increase of galvanising capacity in the order of 30 per cent.

Dorman, Long and Co., Ltd.

At the group of works belonging to Dorman Long and Co., Ltd., there is in progress a number of developments designed to benefit production from the earliest raw material stage right through to the fabricated product for which the company is well known.

Constructional Department.—The main constructional department is being extended in order to facilitate the handling of the longer units which modern construction demands. The department at present consists of six bays 550ft long, with a total width of 500ft. The latest of these bays was put into operation in 1926 and the time has now come for the provision of more "elbow room" to cope with, for example, the 130ft heights which are normal for power station stanchions, as against the 90ft heights which were customary before the war.

Each bay is being extended by about 100ft and across the end a further bay is being constructed running the full width of the existing six bays. The width of this new bay is 100ft, so that the total increase in available length will be 200ft. Added to this must be a gain of about 40ft for the elimination of a rail track at present necessary for handling arrangements. Under the new system the length of the new transverse bay will be continuous with a further 500ft of open gantry for the stock yard. Three 10-ton cranes running over this gantry in the transverse bay will bring the raw material into the bay, where it will have preliminary treatment such as cutting to lengths, straightening, mangling and edge planing. Material will then be placed on transfer cars, which will run the few yards necessary to make the material accessible to the cranes in the longitudinal bays.

It is hoped to complete the longitudinal extensions within the next few weeks and the transfer bay by the autumn of this year. Only two new machines, both edge planers, are being installed, though there is to be a considerable rearrangement of existing plant in order to give the required extra space for longer units. A further expected advantage is that the new handling arrangements will save much shunting transport. This will speed production considerably. The importance of constructional work in the export market is well known, and it is anticipated that this extension will have a direct influence by increasing the export capacity of the works.

Ore Preparation Plant.—Another development which is in progress at the Cleveland works is an ore preparation plant designed to handle 2,500,000 tons of ore per year and sinter 350,000 tons. The work on the screening and crusher house has been held up by bad weather, as has progress on civil engineering work generally, but it is hoped that production will start about a year from now.

The general intention is to concentrate the discharge of ore for the whole group of works at one point. Although this will mean an added haulage to the Redcar and Acklam works, this will be offset by the use of thoroughly up-to-date machinery, made possible by the volume of materials handled. As the main consumption point is at the Cleveland works the unloading will take place there and the ore will be conveyed to the stock piles by electric locomotives. Ore for the Cleveland works will pass through the preparation plant and thence by belt conveyors to the blast furnaces.

The effect on Cleveland of the use of a large proportion of prepared ore is expected to be a substantial improvement in output and an appreciable drop in fuel consumption per ton.

In this connection it should be mentioned that the new unloading arrangements are expected to reduce the time needed for unloading ships of reasonably large size from about five days to two days. This will be accomplished by the installation of transporter cranes which will be assisted by the jib cranes at present used and the construction of a new berth and the improvement of existing berths.

There is one further development in progress which it is hoped to have completed by the end of this year and that is the construction of 4½ miles of private rail track between Cleveland and Redcar works, linking also the Lackenby site where a new universal beam mill and steelworks will ultimately be installed.

Boiler Plant.—Another development is the installation at the Cleveland works, to replace existing plant, of new modern water-tube boilers which are similar in capacity, design and arrangement to those installed in modern medium sized power stations.

The plant consists of three four-drum boilers, each capable of a normal evaporation of 100,000 lb of steam per hour (maximum 125,000 lb per hour) at 450 lb per square inch pressure and 725 deg. Fah. final temperature. Each boiler is complete with economiser, air heater, forced draught fan, induced draught fan, and chimney, and is fitted with mechanical stoker and also five gas burners. The boilers will be fired with blast-furnace gas supplemented with solid fuel when sufficient gas is not available. The solid fuel-firing arrangements are designed to make the maximum use of low grade fuels, such as coke breeze, which may be available. The breeze will be fired on the "sandwich" system, and thus fuel, which in pre-war days was considered almost a waste product, will be used efficiently for raising steam. The fuel is delivered to the plant through a system of conveyors, which reduce the labour required, for what is normally an unpleasant job, to a minimum.

Feed water treatment plant includes a Zeolite softening plant and sheet exchanger, a modern de-aerator, equipment for continuous chemical dosing and treatment.

A submerged ash conveyor takes the ash from the boiler stoker hoppers and delivers

it into a storage bunker, from which it can be discharged into wagons as and when required. A vacuum dust removal plant is also installed for removing all grit and soot from the various boiler and stoker hoppers.

The boilers are equipped with automatic controllers, and the latest type remote controlled automatically operated soot blowers are installed.

The boilers are housed in a large steel-framed brick building, 113ft long, 71ft 6in wide, and 76ft high to the eaves, with the water treatment house and feed pump house built on at one end. About 1000 tons of structural steelwork are utilised in the buildings, bunkers and conveyor gantries, and about 2400 tons of steel in the boiler plant itself.

The new boilers will generate steam at a higher pressure than the old, but the steam will be used at the pressure at which it is generated, as the turbines of two blowers and two generators are being converted to use steam at this pressure, and the supply of the low pressure steam required for the other turbines will be obtained from a new 6000kW pass-out turbo-alternator, which is being installed. In addition to the pass-out steam branch on this new turbine there is a connection for bleed-off steam near the low-pressure end to give a supply of steam to the boiler plant de-aerator. This pass-out machine can supply variable amounts of pass-out steam to suit requirements and, if necessary, it can be run simply as a condensing machine.

Steel, Peech and Tozer

The first major step towards the present modernisation plans at Steel, Peech and Tozer's was the installation in 1944 of a new cogging mill. This mill, with a 42in roll diameter and 7ft 6½in length of barrel, is dealing with a weekly input of 14,000 tons to 15,000 tons, probably the highest of any cogging mill in this country. The new in and out-going roller tables for handling these quantities, the manipulators and the mill train were all designed by Steel, Peech and Tozer's in consultation with and manufactured by Davy and United Engineering Company, Ltd. The resulting increase in production has been in the order of 15 per cent to 20 per cent, together with greater reliability.

An increase in steel production, too, is in course of being effected, by means of improved charging and handling equipment, increased installation of water cooling for vulnerable parts of the open hearth furnaces and by ultimate conversion of eight out of the twenty-one furnaces to oil-firing and two to coal tar oil-firing. Four have already been converted. Total ingot production will be increased by about 10 per cent by these means and, with additional improvements to be made, a further increase in capacity of 10 per cent, bringing the total to nearly 800,000 tons per annum, is expected.

These developments necessitate an increased water supply to the works and a new water supply system, at a cost of £150,000, is planned, work on which has been started. This is to comprise a new filtration plant and a new twin pump house, capable of taking 10,000,000 gallons per day from the Don, an increase over present capacity of 2,000,000 gallons, though the existing reservoir can cope with the increase.

Reorganisation of Wheel and Tyre Mills.—The main item of reconstruction at the present moment is the £250,000 reorganisation of the wheel mill, which is designed to increase the firm's output of railway material by 30 per cent. Almost all existing machinery for the manufacture of railway wheels is to be replaced, much of it in new buildings.

A new mill building, 225ft by 50ft, is being constructed alongside and partly overlapping the present building. This will give much needed elbow room to the department, for which a new warehouse building, 210ft by 80ft, is also being constructed at right angles to the mill building and parallel to the ingot preparation and heat-treatment shops. In the last-named two new gas-fired furnaces are being installed and comprise one continuous hardening and one vertical tempering furnace, with a new water spray treatment machine. In the ingot preparation shop, which has been extended, there is already a new Scriven ingot breaker and a bogie type heating furnace, which is being installed.

New plant to be installed includes a 6000-ton forging press by Davy and United Engineering Company, which it is hoped to set up during this summer; a vertical type wheel rolling mill with its ancillaries; reheating furnaces and improved handling arrangements throughout the shop. All furnaces are fired by coke oven gas piped direct from Oregreave coke ovens owned by the United Steel Companies. The present 2500-ton press is to remain as a stand-by.

The new plant is to substitute hydro-electric power for the steam power at present used on the mills and presses. In the tyre mill a similar substitution is projected.

On the tyre rolling side a new heat-treatment plant has been installed, with new carbon monoxide gas-fired furnaces to cope with the increased capacity. These new furnaces comprise three rotary and three static hearth installations of the circular vertical type.

The net results of these improvements in the wheel and tyre mills will be to increase the space available, making it possible to secure an altogether better flow of material. The wheel mill, in particular, will be improved when the installation is complete, though it must be emphasised that there has been most careful dovetailing of the new machines and layout with existing production facilities, to avoid impeding current output.

The wheel mill layout may be visualised as a capital letter E. Ingots come in at the open end of the top cross stroke, where the new Scriven ingot breaking machine is situated, and also the new bogie type reheating furnace. From there the blocks are taken to the corner of the upright stroke, by a new ground type charging machine, at the moment to the 2500-ton press, which is just about on the corner, but later they will go to the 6000-ton press, which will be substituted at a point rather further across the upright. The new reheating furnace and new wheel rolling mill are spread along the upright and serviced by a second new charging machine. The 1500-ton dishing press, not new, but transferred from a position further up the shop, is about opposite the lowest cross stroke of the E, and is also fed by this charging machine. The dished wheels are taken off by a third new charging machine running on the same track as the second. This feeds them either direct to a new water spray treater in the lower corner of the bottom cross stroke (the new warehouse bay) from where the overhead cranes in this bay transfer them to slow cooling bins, about halfway along the warehouse. Alternatively, the overhead cranes may take them direct to a transfer bogie towards the end of the shop, whence the wheels are fed into the new continuous hardening furnace and vertical tempering furnace situated at the "open" end of the cross centre stroke, together with another new water spraying machine. This bay also contains the press tool lathes which it has not been necessary to replace.

At a time when railway transport difficulties are threatening to impede the national recovery considerably, an increase of 30 per cent in Steel, Peech and Tozer's output of railway materials is a valuable development.

At the same time, there are various projects in hand with the general object of saving fuel and increasing efficiency. The small bar and section mills, for example, are to be electrified, and increased stock accommodation is being provided in the finishing department, while the railway spring department has been laid out anew and mechanised. The engineering shops are in course of rebuilding and more modern maintenance machinery is being installed.

Eighteen waste heat boilers are planned for installation in the melting shops. The first stage allows for six Cochran Sinoflo boilers, each to evaporate 12,000 lb of steam per hour at 180 lb per square inch. Two such boilers are installed and two are to follow fairly soon. It is expected to complete the full installation within the next two years, which will enable practically all the Lancashire boilers to be eliminated. In the interim, a number of the Lancashire boilers are being converted to oil-firing. The ultimate saving of fuel that the waste heat boilers will effect is expected to be 19,000 tons per year.

The Practical Training of Electrical Engineers

A report recommending the further development of schemes of practical training for professional electrical engineers is published this week by the Institution of Electrical Engineers. The report has been prepared by a joint committee consisting of representatives of the British Electrical and Allied Manufacturers' Association, the Radio Industry Council and the Institution of Electrical Engineers. Copies can be obtained, price 1s. post free, from the Secretary of the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Two types of apprenticeship are recommended in the joint committee's report, namely, graduate apprenticeships (lasting two years) for those who obtain their technical education at universities by means of full-time university courses and student apprenticeships (lasting four years) for those attending part-time courses at technical colleges. Both types of apprenticeship are divided into three parts: basic mechanical training, during which the apprentice obtains experience in the chief methods of manufacture and comes into close contact with a variety of craftsmen and other workers; basic electrical training designed to introduce the apprentice to the special problems connected with the manufacture and testing of a particular type of electrical equipment and office training which will give him insight into drawing-office and planning department methods in preparation for an appointment as a junior engineer. Operating organisations and other concerns which may be unable to provide all the phases of training recommended are advised to arrange for an exchange of apprentices with allied organisations.

It is recommended that all apprentices who have not obtained educational qualifications equivalent to those required for election to the class of graduates of the Institution of Electrical Engineers should be released from the factory on one day in each week to enable them to attend part-time courses in electrical engineering at technical colleges, and satisfactory progress in these courses should be a condition for the continuance of the apprenticeship. Those who obtain a Higher School Certificate in suitable subjects and intend to take a university course would be well advised to serve the first year of their apprenticeship before entry to the university, as this would help them to take greater advantage of the educational and cultural facilities afforded by the universities. Those who have commenced a form of training as craftsmen or technicians and who show sufficient promise should be given an opportunity of transferring to student apprenticeships.

Stress is laid upon the means of encouraging the apprentices to take part in and to organise social, athletic and educational activities outside working hours. An Apprentice Association should be formed where this is practicable and employers should encourage the technical colleges in their endeavours to develop a better corporate life amongst the students.

In its report the joint committee recommends that the supervision of the apprentices should be undertaken by a special department concerned with all types of training and that the individual responsible for the co-ordination of training should be a chartered electrical or mechanical engineer with direct access to the executive director concerned with long-term plans for the supervision of staff.

An International Mathematics Union.—A proposal to set up an International Mathematics Union was warmly supported by a meeting of mathematicians from Europe and America, which was held at UNESCO House on June 24th, under the auspices of the Mathematical Society of France.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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PRACTICAL TRAINING FOR PROFESSIONAL ELECTRICAL ENGINEERS

IT is fitting that the Institution of Electrical Engineers, whose first object is "to promote the general advancement of electrical science and engineering," should accept responsibility for offering general guidance on the education and training of electrical engineers. Evidence of the growing importance of these matters is contained in the admirable series of reports that have been published at intervals since the Institution set up its post-war planning committee in 1941. It is fitting, too, that the electrical industry, which is the main beneficiary, should take an active and practical interest in the training of engineers. That the Institution and the manufacturing industry should co-operate in this sphere is an important development, giving added weight to the report on the practical training of electrical engineers, which was published at the beginning of this week. This report, which is briefly summarised on another page, was prepared by a joint committee, under the chairmanship of Sir A. P. M. Fleming and consisting of representatives of the Institution of Electrical Engineers, the British Electrical and Allied Manufacturers' Association and the Radio Industry Council. It should be stated, in passing, that whereas this report is concerned with professional engineers, the committee's terms of reference were somewhat wider, and that it is intended to prepare a further report on training for technicians.

The report under review recognises the existence of two main approaches to the practical training of professional engineers—graduate apprenticeship lasting two years, which need not be continuous; and student apprenticeship, lasting four years, for those who prefer to obtain their technical education through part-time study. Wisely, in our opinion, the committee has refrained from expressing any preference for either scheme, leaving the choice to be made by each individual, guided by personal preference, aptitude and circumstances. In the same way, the third form of apprenticeship, which forms part of the so-called sandwich course, is recognised as providing an alternative which is essentially a compromise between the student and graduate apprenticeship. An interesting point about the graduate's two-year apprenticeship is the recommendation that the forty-four weeks of basic mechanical training and the subsequent thirty-six weeks devoted to basic electrical training should be followed by twenty-four weeks of office training, which should be divided equally between the planning or progress departments and the drawing-office; a slightly longer period in the offices is included in the scheme for student apprentices. General approval will also be accorded to the proposal that one-third of the graduate's "basic electrical" training should be spent in departments where the apprentice can acquire a basic knowledge of the electrical and mechanical properties of the materials, particularly dielectrics and of the processes used in applying them to the production of electrical equipment.

Interest and comment on the report will be centred as much on the broad conception of the committee's recommendations as on the details of the various schemes which are set out in a number of schedules. An important section of the report is that which deals with what might be termed the apprentice's "extra-mural" activities—participation in the life of apprentice associations and in works social events. It would be difficult to exaggerate the importance of this side of the apprentice's life in developing character and personality, which are among the most prized of all the assets that the professional engineer can command. Another portion of the report that is worthy of close attention is the section dealing with the post-apprenticeship period, including the placing of apprentices and their training for junior staff appointments. Even more important, in our view, are the recommendations of the report for the organisation and supervision of the apprentice's training, and the suggestion that these matters should be the responsibility of one person—a professional engineer. The approach to these matters, which includes the steps to be taken to recruit and select apprentices will play a big part in determining the success or failure of any individual training scheme. In conclusion, it can be regarded as significant, rather than fortuitous, that this valuable report should have been published so soon after the Memorandum by the Ministry of Labour on the deferment of call-up of engineering students born in 1929. The coincidence of these two documents serves to underline the extent to which a still young and progressive industry which is growing rapidly in size and scope will depend upon the quality and numbers of its professional engineers.

THAMES FLOODS

THE country-wide floods of March this year at the end of that cold spell which was the immediate cause of the fuel crisis were not, in general, of unprecedented magnitude. Yet they were undeniably very heavy and the damage and inconvenience caused by them was widespread. In the hope that an examination of the flood levels reached, in conjunction with an assessment of the damage done and the numbers affected, might prove of value in calculating what preventive measures might prove justifiable in future the Minister concerned last April asked Catchment Boards to furnish as much information as possible about them. A report on the flooding in the Thames valley by Mr. R. V. W. Stock, Chief Engineer of the Thames Conservancy Board, drawn forth by the Minister's request, was published early this week. The Thames flood, though a particularly high one—the greatest for fifty-three years—did not attain the magnitude of that of 1894, which has come to be regarded as a "reference" by which the magnitude of other floods may be measured. But it was unusual in its causes. For heavy and continuous rainfall was less responsible than a combination of a more normal precipitation, falling upon frozen ground and thus running off more rapidly than usual to the river, with a general thaw melting snow which had lain for some time on the ground. In the result the rise in level of the river was particularly rapid and it is probable that it was the rate of rise rather than the high level reached which was the cause of danger to the inhabitants of dwellings in the flooded areas.

Of course, the occurrence of a flood of unusual magnitude always raises the question whether preventive measures are possible and whether their cost would be justified. That question, as it relates to the Thames valley, is carefully, though briefly, considered in Mr. Stock's report. Broadly, there are three methods that might be used to control or to alleviate flooding—reservoir projects, embankments, and river channel and weir improvement works respectively. The possibilities of each are examined by Mr. Stock, and each is rejected as unsuitable for the Thames valley. To control flooding by the construction of reservoirs would require a capacity of some 160,000 million gallons, equivalent, as Mr. Stock points out, to about twenty-four basins, each equal in capacity to the Metropolitan Water Board's great "Queen Mary" reservoir at Littleton. Apart from the very great difficulty of finding suitable sites for such a number of basins, the cost would reach £78,000,000 and nearly 17,000 acres of land would be permanently withdrawn from agricultural use. Nor can the alternative of damming valleys to create storage space be reasonably contemplated in so densely inhabited an area as the Thames catchment owing to the disturbance caused by the submergence of houses, roads and railways and the cost of removal and diversion. Embanking can hardly be regarded as practicable. Such banks would have to

extend along the whole length of the main river and presumably far up many of the tributaries, so that the cost inevitably would be very high. At first sight, then, the third alternative of widening the river sufficiently to carry floodwaters seems more practicable, more especially since from time to time works of such a character have been carried out locally. The new "Desborough" auxiliary channel between Shepperton and Walton bridge, constructed just before the war at a cost of £300,000 is an example of just such a work. It is computed to have had the effect in the recent flood of lowering the maximum Shepperton tail water by about 12in. Such works are, indeed, characterised by Mr. Stock as "the only practical method for controlling a Thames flood." But since the present maximum flow, as measured at Teddington, which can be contained within the river banks amounts to 5000 million gallons per day, whereas to contain the maximum probable peak flood provision would have to be made for a flow of 15,000 million gallons per day, the works would inevitably be of such magnitude that, to quote again from the report, "the River Thames, as known the world over, would virtually disappear, its place being taken by a waterway of a widely different character."

Can then nothing be done to alleviate if not to prevent flooding in the Thames valley? In Mr. Stock's opinion, "the most practical solution of the problem is . . . to delineate a flood zone on either side of the river throughout its length, the tributaries being similarly dealt with later." In effect, the proposal is to allow the river to use its immemorial method of relieving a flood by spreading out over the flood plains. We may agree with Mr. Stock that, provided due warning can be given of imminent flooding little harm and not even very much inconvenience is so caused in rural areas. But the crux of the problem in reality lies in the effects of flooding upon riverside urban and built-up areas. It is apparently contemplated that even in such areas delineation should apply. "The built-up areas do, of course, present a complex problem and one of some magnitude amounting, as it must, to the eventual evacuation of people living therein and businesses located there." It has, indeed, for some time been the policy of the Conservators to discourage building in areas liable to floods, and the attention of town planning authorities was drawn to the "advisability of prohibiting the building of dwelling-houses permanently on low-lying land subject to flooding" in a Resolution sent to all local authorities in the catchment areas in 1936. But the eventual evacuation of houses and businesses already sited in such areas is, we think, an altogether different matter. The principal local authorities have recently been approached for information about the extent, depth and duration of flooding last March, and the number of people, houses and streets affected. Not until that information is available will it be possible precisely to evaluate how much property would be affected by delineation and how much disturbance of road and rail traffic might be involved. It is possible that less disturbance might be created and a real economy achieved by combining delineation with works, such as those proposed by Mr Buckley in 1930 and by Mr. G. Bransby Williams in 1937 for alleviating flooding. But it would, obviously, be unprofitable to study those possibilities in detail until the reports by local authorities become available.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"STRAIGHT" I.C. LOCOMOTIVES

SIR,—I read Mr. John Alcock's letter in your issue of June 27th, with some puzzlement, for it is well-known that the "straight" or direct drive diesel locomotive is not a satisfactory proposition. It appears, however, that Mr. Alcock is actually referring to a diesel engine coupled to the locomotive driving wheels through a mechanical torque converter with, presumably, a clutch—a transmission system which, however excellent, it is surely incorrect to call "straight," though it is admittedly straighter than other indirect drives, such as the diesel-electric combination.

I am interested in this matter, since I have been trying for several years to get a direct drive gas locomotive developed in this country. This would be a truly "straight" internal combustion locomotive, requiring neither clutch nor change-speed gears; the pistons driving the wheels through connecting rods and cranks, as in the steam locomotive.

A few more details concerning this proposed locomotive may be of interest to your readers. It is designed to provide steam engine flexibility with improved tractive effort/speed characteristics, and considerably more power for the same weight and overall dimensions. The thermal efficiency at normal speeds will be the same as that of the diesel, but there being no torque conversion losses, the overall efficiency will be higher than that of any diesel locomotive.

At starting and at low speeds and maximum tractive effort, the efficiency will be somewhat lower, but still considerably above that provided by, for instance, the diesel-electric combination in the same circumstances.

The locomotive is intended to burn compressed coal gas and its general use in this country in place of steam locomotives could result in a saving of some 10,000,000 tons of coal per annum. This would be a genuine saving—not one made at the expense of importing more oil from abroad.

Railway enthusiasts may like to know that the gas locomotive will not only look like a steam locomotive, it will also puff like one—if it ever puffs at all!

Several eminent engineers have agreed that the engine appears to be a practical proposition, so far as can be judged without actual trial. But for one reason or another it has not yet been possible to get the development work started.

É. F. R. TOWNSHEND.

Portsmouth, July 12th.

Literature

SHORT NOTICES

Reference Data for Radio Engineers. By W. L. McPherson. London: Standard Telephones and Cables, Ltd. 5s. net, postage 6d. extra.—This reference book was originally compiled and published in 1942 for the benefit of radio engineers on the staff of Standard Telephones and Cables, Ltd. Now that the book has been made generally available, it will be welcomed by all who require ready access to a comprehensive source of information on radio engineering data. Although the scope of this second edition is necessarily restricted, it is by no means narrow. The additional matter includes new or greatly expanded sections dealing with such varied branches of radio as transmission lines, wave guides, aerial radiation and propagation data, selenium rectifier practice, network and circuit theory, and the analysis of non-sinusoidal wave forms. In a reference book of this sort the presentation of certain complicated functions in tabular form will commend itself to those readers who value the degree of accuracy that is usually lacking in graphical presentation. The section devoted to mathematical tables is fairly comprehensive, and includes tables of Bessel functions which are becoming increasingly important to the radio engineer with the introduction of frequency modulation and the development of wave-guide technique.

Installation and Care of Electrical Power Plant. Manchester: Emmott and Co., Ltd. 3s. 6d. net.—This small book of 133 pages forms a useful addition to the series known as "Mechanical World Monographs," and should appeal to the non-specialist user of electrical power plant. Most of the book is devoted to electric motors and there are separate chapters dealing with the characteristics of motors, overheating and its causes, portable electric tools, and the installation and care of motors. Starting and control gear is adequately treated, and a separate chapter is included to deal with control gear for single-phase and special forms of three-phase motors. The distribution side is covered in four chapters dealing with switchgear and transformers, medium and low-pressure switchboards, and power distribution gear. Not the least important part of the book is that devoted to the practical implications of power factor correction. The value of the book would, however, have been enhanced by the inclusion of an index.

Patents of Invention. By Allan Gomme. London: Longmans, Green and Co., Ltd., 43, Albert Drive, S.W.19. Price 1s. 6d. net.—This little book traces in an interesting manner the origin and growth of the patent system in Britain. It has been published for the British Council. The author was the librarian of the Patent Office until 1944, and is a recognised authority on the historical aspects of patent law and practice. The introductory chapters deal with the somewhat obscure origin of patents, and show that, as far as can be traced, the fourth known patent to be granted was issued in this country to one John of Utynam in 1449. This patent had no known successor until one was granted in April, 1552, to a Henry Smyth. That patent inaugurated the long record of this country, which Mr. Gomme goes on to deal with in an authoritative and entertaining way.

BOOKS RECEIVED

The Experimental Study of Structures. By A. J. S. Pippard. London: Edward Arnold and Co., 41, Maddox Street, W.1. Price 9s.

Rotary Valve Engines. By M. C. I. Hunter. London: Hutchinson and Co. (Publishers), Ltd., 47, Princes Gate, S.W.7. Price 21s.

Plastics in Industry. By A. E. Williams. Manchester: Emmott and Co., Ltd., 31, King Street West, Manchester, 3. Price 2s. 6d.

The Amateur's Workshop. By Ian Bradley. London: Percival Marshall and Co., Ltd., 23, Great Queen Street, W.C.2. Price 7s. 6d.

Oxy-Acetylene Welding Handbook. Second edition. By L. J. Tibbenham. Stowmarket: Suffolk Iron Foundry (1920), Ltd., Sifbronze Works. Price 5s.

Servomechanism Fundamentals. By H. Lauer, R. Lesnick and L. E. Matson. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 17s. 6d.

Cutting Tools for Metal Machining. Second edition. By Professor Max Kurrein and Professor F. C. Lea. London: Charles Griffin and Co., Ltd., 42, Drury Lane, W.C.2. Price 28s.

Fault Localising and Testing on Electric Mains. By F. Charles Raphael and Charles A. Grover. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 20s.

The Institution of Civil Engineers' Conversazione

THE conversazione of the Institution of Civil Engineers, the first post-war function of its kind, took place on Thursday evening, July 10th. There was a large attendance of members and guests. The guests were received in the Great Hall by the President, Sir William Halcrow, and the Council of the Institution. During the evening an entertaining and interesting lecture was given by Mr. W. F. Grimes, M.A., F.S.A., the Director of the London Museum, on "Roman London." Musical entertainment was contributed by The Royal Artillery Orchestra, under Major O. W. Geary, Director of Music, R.A., and there was a violin recital by Miss Olive Zorian. Refreshments were served during the evening in the North and South Reading Rooms and the Council Room. A very enjoyable evening was spent.

Display of Models

Among the engineering models and scientific apparatus displayed in the library, the following call for mention: A fine model of a Portland cement plant, designed for an annual output of 250,000 tons, was shown by Vickers-Armstrongs, Ltd. It is equipped with reflex kilns, and has an air-swept pulverised fuel-firing installation.

Reference has already been made in these columns to the Arc of Noah competition, organised by the Worshipful Company of Shipwrights at its recent exhibition. It was interesting to see once more the 1st and 3rd prize winning models in that novel competition, which we may recall were gained by J. Samuel White and Co., Ltd., of Cowes, and the Tyne Dock and Engineering Company, Ltd., of South Shields.

An appropriate exhibit, in connection with the forthcoming completion of the new Brabazon aircraft, Bristol Type 167, at the Filton works of the Bristol Aeroplane Company, Ltd., was the model of the new hangar to contain the aircraft shown by Brian H. Colquoun, B.Sc., A.M.I.C.E. It has an overall hall width of 1052ft. The overall depth of the full centre bays is 420ft and that of the half-bays, 270ft. It has a clear span at the roof trusses of 83ft and a height to the roof of 117ft. The floor area is 325,000 square feet, or about 7½ acres, and the area of the apron is 290,000 square feet, or 6⅔ acres, while the size of the north window is 1045ft long by 50ft high. The doors are 1045ft long and have a height of 65ft 9in. The construction of this great hangar, reputed to be the largest in the world, is a bridge-building job, and interesting features are the glass and asbestos-sheet cladding and the ingenious arrangement whereby two 65ft high travelling cranes are made to serve any point in the centre bay, an area of 420ft by 330ft, by crossing from one travelling gantry to another.

An interesting exhibit was that arranged by Mr. H. F. Cronin, B.Sc., M.Inst.C.E., chief engineer of the Metropolitan Water Board, to show the design and development of shear boxes for testing sandy gravels. In the large machine built in the Board's workshops to the design of Mr. A. W. Bishop, M.A., A.M.I.C.E., samples 12in in area and 6in thick are tested. This machine has been lent to Imperial College, where research is being carried out on the relations between grading, density and the angle of friction for sands and gravels. The principle of the machine is that lateral force is applied to the upper and lower parts of the split box containing the sample, and the pressure required to separate them is measured by the change in internal diameter of a steel ring with a micrometer gauge. Three smaller machines incorporating a new design of shear box with a constant rate of strain-loading device, also designed by Mr. Bishop, were shown by Mr. A. W. Skempton, M.Sc., A.M.I.C.E., of Imperial College. Close agreement is shown, it is stated, between the results obtained with small and large shear boxes, and an interesting table indicated the changes in practice which had taken place in the determination of shear stress in the past century. It was pointed out that the 1946 box designed by Mr. Bishop represented what was perhaps the final stage in the development of the shear box from its original form used by Alexander Collin, in his classic study of clay slopes in 1846.

Amongst the models shown by Sir Charles Darwin, Director of the National Physical Laboratory, was an instrument designed by Mr. L. E. Prosser and Mr. G. A. Y. Young, of the Engineering Division, to measure the impact force on a small submerged vane by an electronic balance above the water surface. The instrument shown was designed for use on the 20ft wide gantry spanning the River Forth model at the N.P.L. but it was exhibited operating on a tidal model made in miniature and having a length of about 5ft. Another N.P.L. model was that showing the use of a water model for ventilation experiments. A small 1–48 scale water model of Dr. Faber's design for the ventilating system for the Debating Chamber of the new House of Commons was exhibited. Water is led through a duct under one gallery and being cooler than the water in the model, which is electrically heated, it falls in a curved path and induces a circulation towards the faces of the occupants in the gallery. The flow pattern produced is rendered visible by the injection of dye into the water.

Specimen sands and their properties were illustrated by Mr. A. L. Little, B.Sc.(Eng.), A.M.I.C.E., who exhibited models showing the effect on sand foundations of different conditions of pressure and moisture. A permeameter was used to display the phenomenon of "piping" or "boiling" familiar to civil engineers.

Models shown by Dr. F. M. Lea, director of the Building Research Station were, designed to show the electro-chemical hardening of clays, and the measurement of strain by means of a radio link between the strain-gauge and the recording equipment. The hardening of London clay by aluminium anodes passing current into the soil was illustrated. The introduction of aluminium ions results in a base exchange, which causes the clay around the anode to become much harder than the ordinary London clay. The practical use of this process is being studied in relation to increasing the bearing capacity of friction piles in soft clays and for the stabilising of clay slopes. The research has also shown that under electrical treatment, important changes take place in the structure of the clay which are thought to bear a significant relation to the structures observed in natural clays. The laminated structure formed in the vicinity of the cathode and the polygonal crack formation were illustrated by the model.

Road Research Models

Dr. W. H. Glanville, M.I.C.E., director of the Road Research Laboratory, exhibited three models. One showed how an electric current could be used to produce water movement in a saturated soil of very low permeability, a method often used to facilitate the construction of foundations in river silts.

Another showed soils which had been waterproofed by mixing with them small quantities of resinous materials or bitumen. Two examples were the use of 1 per cent of "Vinsol," a powdered resin product, and the other a 3 per cent mixture of Shell Stabilising Oil. A third model was constructed to show the phenomenon of mud pumping, and it represented the joint between two concrete road slabs, one of which was made to deflect under traffic, due to foundation weakness and to force up mud through the joint.

Dr. Reginald Stradling, D.Sc.(Eng.), M.I.C.E., chief scientific adviser the Ministry of Works, exhibited drawings and photographs designed to illustrate the effect of blast from atomic bombs at Hiroshima and Nagasaki on ten buildings. The material was selected from the reports of British observers who visited Japan.

Mr. Du-Plat Taylor, M.I.C.E., showed in operation two working machines which he has designed for the National Institute for the Blind. They comprise a map and diagram embossing machine and a Braille transcribing machine. The Technical Research Committee of the Institute was, in 1939, engaged on the design of a machine for embossing maps and diagrams on plates, thereby enabling prints in any number to be embossed on paper. Work on the machine was continued during the war, and all difficulties have now been solved. As the pointer moves over the map or diagram to be copied, the zinc sheet is made to follow a corresponding path. The die, which embosses the plate, is actuated by a solenoid. Even spacing between the dots is achieved by means of a thread which unwinds as the carriage moves and so rotates a commutator. The solenoid is energised at each make of the contact. With this machine, the size and shape of the dot can be varied and it is estimated that a map or diagram can be produced in about one tenth of the time previously taken.

The Braille transcriber is electrically operated and it has six keys and a space bar. When a key is pressed the corresponding style is wedged forward and the counter-die moves in and embosses a double sheet of zinc.

Automatic Sluice Model

A hand-made model shown by Mr. F. M. Andrews, M.A., A.M.I.C.E., was built in 1940 to test, under working conditions, certain features of a new design of automatic sluice. It is made to the scale of 1in to the foot from the design of a full-size sluice. The length of the concrete floor of the sluiceway is 3ft 4in and the width 1ft 10in, and the reinforced concrete walls are 2ft 10in in length, with a height of 9in. The fabricated brass radial sluice gate has a width of 8in and a height of 5in, and the counterbalance vessels are 5in in diameter and 2½in

deep. The new design is useful in cases where automatic operation solely through the agency of the water contained is required without the use of electricity or other forms of power. The sluice gate is counterbalanced by two cylindrical vessels suspended within water-tight manholes from conical or spiral pulleys. When the water upstream of the gate rises above a certain level it flows into the vessels through adjustable V-notch weirs, which are set at the desired level to discharge at a predetermined rate through small gratings and flexible pipes in the side walls upstream of the gate. The rate of outflow from the vessels to the downstream side of the gate, through flexible pipes, is controlled by adjustable notch weirs in the vessels. When the rate of flow into the vessels exceeds that of the outflow the weight of water accumulated therein causes the vessels to descend, and the sluice gate to rise or open. As movement occurs, the weight ratio of the vessels and the gate increases due to their suspension from pulleys of varying diameters. Further movement is thus arrested, until either a further rise in the contained water upstream of the gate increases the flow into the vessels, causing them to descend further with a corresponding rise in gate, or a fall in the level of the contained water reduces the rate of flow to the vessels, which will then empty, and ascend whilst the sluice gate descends or closes. Prior adjustment of the level of sill and the opening of the notches ensures that the gate shall commence to rise and shall also be fully drawn at predetermined levels of the contained water, and shall operate by degrees between these levels. A number of sluice gates of this new type have been completed in the last three years, and are, we learn, proving satisfactory in operation.

A model of the new sea wall at Pett, near Rye, Sussex, now under construction, was shown by Mr. C. H. Dobbie, B.Sc.(Eng.), M.I.C.E. It was made with "Perspex" ends to show the materials actually used. It is essentially a clay wall protected by concrete block-work, with bitumen jointing. A berm of local material has been interpolated in the wall to divide the wave action.

Sea forts, described in THE ENGINEER, during the war, were illustrated by a model lent by Sir Arthur Whitaker, M.Eng., M.I.C.E., civil engineer-in-chief of the Admiralty. The forts, we may recall, were constructed under the direction of Sir Arthur, and Mr. G. A. Maunsell, B.Sc.(Eng.), M.I.C.E., who also prepared the design. They were built at riverside sites on the Thames and were floated out to their action stations in the Thames Estuary and were there sunk on the sea-bed, so that only the superstructure and roughly the upper third of the towers were visible above water.

Models made from aerial photographs were shown by Mr. P. G. Mott, B.A., A.M.I.C.E., and this method may be applied to the needs of town planning and other development schemes.

The high-pressure swashplate hydraulic pump shown by Mr. T. E. Beacham, B.Sc., M.I.C.E., is described on another page of this issue.

A new type of mathematical differentiator, which was developed during research work carried out at the City and Guilds College and used in Ministry research departments, was exhibited by Mr. J. G. Thom, M.Sc., A.M.I.C.E. It is a device providing a means by which the value of the tangent of any angle up to ± 45 deg. can be directly read from the vertical scale of the instrument. For angles greater than 45 deg. the cotangent can similarly be read from the horizontal scale of the instrument. It thus covers the range of 180 deg. When in use the instrument is placed on the curve so that the curve is intersected by a mirror at the point at which the tangent has to be read, and in such a manner that scales are parallel to the axes of the curve. The indicating arm carrying the mirror is then rotated so that the curve in front of the mirror and its image form a continuous line. The value of the tangent or cotangent is then read directly on the scale, which is intersected by an indicating line on the rotating arm. The simplicity of operation is enhanced by the fact that it is not necessary to determine accurately the centre of the mirror. Any deviation is allowed for by the indicating line, which remains parallel to the tangent if not tangential itself. Diagrams illustrating the accuracy of differentiation were shown.

Electrical and Light Units at the N.P.L.

OFFICIAL announcements from the National Physical Laboratory at Teddington refer to electrical and light units. We reprint them in full below.

ELECTRICAL UNITS

In accordance with decisions taken by the International Committee of Weights and Measures at its meeting in Paris in October, 1946, the system of electrical units employed at the National Physical Laboratory will be changed on January 1, 1948. The units at present in use are the "international" units, which are based on certain material standards. From January 1, 1948, the units employed will be those derived from the centimetre, gramme and second, *i.e.*, the so-called "absolute" units. The effects of this change may be seen from the following table :—

International.	"Absolute."
One ohm	1·00049 ohms
One volt...	1·00034 volts
One ampere	0·99985 ampere
One watt	1·00019 watts
One henry	1·00049 henries
One farad	0·99951 farad

The factors given in this table apply to the mean international units ; that is to say, to the mean values of the international units as realised at the various national laboratories.

After January 1, 1948, apparatus submitted to the Laboratory with a view to the issue of a National Physical Laboratory Certificate of Examination will be regarded as acceptable if its errors fall within the specified limits when the values are expressed in either international or absolute units, provided that it was manufactured before January 1, 1949, and is marked accordingly. Apparatus manufactured after January 1, 1949, and any apparatus not marked with the date of manufacture, will be acceptable only if its errors fall within the specified limits when the values are expressed in absolute units.

THE UNIT OF LIGHT

Following the decision of the International Committee of Weights and Measures, the National Physical Laboratory will, on and after January 1, 1948, express all photometric values in terms of units based on the "new candle." This unit of luminous intensity is of such a magnitude that the brightness of a full (or cavity) radiator (black body) at the temperature of solidification of platinum is 60 new candles per square centimetre. The new lumen is the luminous flux radiated within unit solid angle by a uniform source having a luminous intensity of one new candle. The new unit of illumination will be one new lumen per unit area. One new lumen per square foot will also be called one new foot-candle and one new lumen per square metre one new lux. The new unit of brightness will be one new candle per unit area, and, alternatively, one new foot-lambert. The latter unit is defined as the brightness of a perfectly diffusing surface of 100 per cent reflection factor when its illumination is one new lumen per square foot.

When differences of colour are involved in the determination of any magnitude in terms of the above units, the evaluation will be in accordance with that which would be obtained by an observer having the relative luminosity curve (curve connecting eye sensitivity with wavelength) adopted by the International Commission on Illumination in 1924 and later by the International Committee of Weights and Measures.

The differences between the new units and those in use hitherto are small. The present units, based on the "international candle," were introduced on April 1, 1909, in Great Britain, France and the United States of America and were adopted in 1921 by the International Commission on Illumination. Nevertheless, Germany and some Central European countries continued to use units based on the Hefner candle (about 0·9 international candle). The international candle was not based on any primary standard ; it was derived from the units defined in terms of the old flame standards and was maintained by means of carbon and tungsten filament electric lamps. Further, the values of the unit at different colour temperatures did not exactly agree, when compared on the basis of the international relative luminosity curve adopted in 1924.

The magnitude of the new unit has been so chosen that it will introduce only very small changes (less than 0·5 per cent) in the values of luminous intensity assigned to lamps operating at a colour temperature of about 2360 deg. K. For lamps at considerably higher colour temperatures, *e.g.*, ordinary gas-filled electric lamps at normal efficiencies, the values expressed in terms of the new candle will be several per cent lower than those expressed in international candles. At the colour temperature of the primary standard (2046 deg. K.), values in terms of the new candle are about 1·7 per cent higher than those in terms of the international candle. On account of this alteration in the basis on which sources of light of different colours are compared, it is impossible to give a factor for converting values in international candles to values in new candles.

Electronic Speed Control of A.C. Commutator Motors*

THE variable-speed a.c. commutator motor (Schräge type) has been in use for many years, chiefly in the textile, paper-making and printing industries. The demand for close speed regulation is of special importance in certain of these applications, in particular that of paper-making machines. Hitherto certain types of speed regulators have been used, which have acted through reversing contactor gear on the a.c. pilot motor used for the purpose of rotating the brush gear in such a direction as to raise or lower the speed of the main motor as required. Quite apart, however, from the obvious difficulties encountered in attempting to achieve high accuracy and rapid speed of response with freedom from "hunting," the maintenance cost of the contactor gear has been high owing to its frequent operation.

Electronic speed regulators have been developed for this particular application, the general arrangement being as shown in the diagram overleaf. The a.c. commutator motor is provided with a d.c. shunt-wound pilot motor M which is coupled to the brush gear of the main motor through gearbox G. A d.c. tachometer generator, driven from the main motor shaft, is used to provide a voltage proportional to speed. This is compared with a datum voltage, which can be varied for the purpose of adjusting speed. The difference voltage is amplified and used for controlling two half-wave rectifiers, connected in inverse parallel, which provide armature power for the pilot motor M.

The tacho-generator voltage e_g is compared with a datum voltage e_1, which can be varied

*Abstract. Paper, "Some Industrial Electronic Servo and Regulator Systems," by E. W. Forster and L. C. Ludbrook. I.E.E. Convention on Automatic Regulators and Servo Mechanisms, London, May 19 to 22, 1947.

by means of the speed-control rheostat P_s, the difference voltage $e_i - e_0$ being applied to the grid cathode circuit of amplifier valve V_1. The resistors R_1, R_2 and condensers C_1, C_2 comprise the stablising network to prevent hunting. The speed-control rheostat and amplifier are supplied from an h.t. rectifier energised from the a.c. supply, the h.t. voltage being stabilised by the voltage stabilisers V_4, V_5 and V_6. The amplifier V_1 controls two valves V_2 and V_3, the former having its control grid and the latter its cathode connected to the stabilised supply. The grid voltage of the former is therefore $e_1 - e_2$ and of the latter $e_3 - e_4$. Valves V_2 and V_3 control the speed of the pilot motor M in a manner exactly similar to that described for the Ward-Leonard control in an earlier part of the paper.†

The coils L'_r and L'_l are the d.c. coils of the phase shift control reactors, the a.c. coils of which, L_r and L_l, are connected in the phase

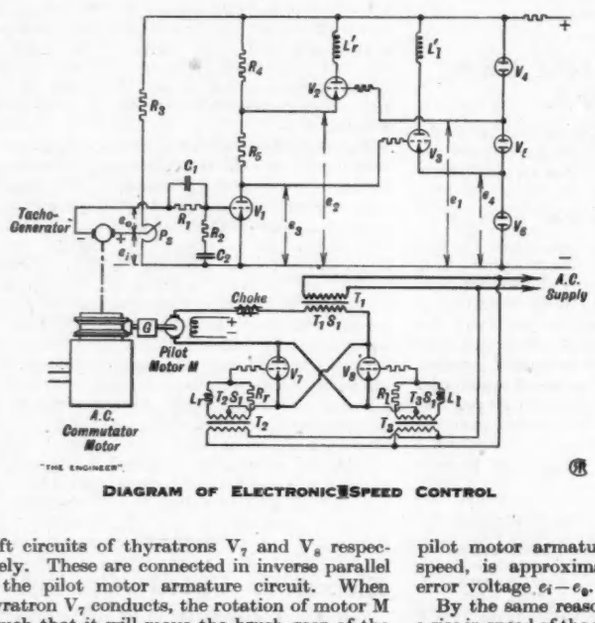


DIAGRAM OF ELECTRONIC SPEED CONTROL

shift circuits of thyratrons V_7 and V_8 respectively. These are connected in inverse parallel in the pilot motor armature circuit. When thyratron V_7 conducts, the rotation of motor M is such that it will move the brush gear of the main motor to lower speed. Likewise, thyratron V_8, when conducting, will cause motor M to rotate in the opposite direction to raise the speed of the main motor. The phase shift circuit of thyratron V_7 consists of the transformer winding T_2S_1, the inductor L_r and resistor R_r, and that of thyratron V_8 transformer winding T_3S_1, inductor L_l and resistor R_l.

It was explained in another section of the paper‡ that an increase of inductance in the phase shift circuit retards the phase of the thyratron grid voltage with respect to its anode voltage, and in so doing allows conduction to take place later in the positive half-cycle of anode voltage, with a resulting decrease in the mean voltage applied to the motor armature. It was also shown that an increase in inductance was brought about by decreasing the d.c. component of flux in the magnetic circuit of the reactor, *i.e.*, by a reduction of current in the d.c. winding of the reactor.

When the anode current of valve V_2 exceeds that of V_3 the pilot motor M rotates in one direction. Rotation in the opposite direction will occur when the anode current of valve V_3 exceeds that of valve V_2. It should be noted that when the anode currents of V_2 and V_3 are equal the voltage applied to the motor armature will be alternating and no rotation will take place, the assumption being made for the sake of simplicity that the characteristics of the reactors and phase shift circuits are identical. In practice, this would seldom be the case, but it is of no consequence, since the condition for "standstill" of the pilot motor M is satisfied automatically by a slight out of balance of the valve anode currents. At standstill it is arranged that the grid voltage of each thyratron will be practically fully retarded to limit the heating of the pilot motor armature due to the a.c. ripple current.

The operation of the circuit may be followed more readily by starting off with the assumption that the main motor is running under automatic control at some constant speed, as determined by the setting of rheostat P_s. The anode current of valve V_1 will then be such that the grid voltage $e_1 - e_2$ of valve V_2 will equal the grid voltage $e_3 - e_4$ of valve V_3, once again assuming that both valves have identical characteristics. The actual values of the grid voltages $e_1 - e_2$ and $e_3 - e_4$ depend on the potential drop across resistor R_5, and therefore this determines the anode currents of valves V_2 and V_3, and consequently the a.c. ripple current in the pilot motor armature circuit at standstill.

If therefore the load on the main motor is increased, the speed will fall. The tacho-generator voltage e_0 will also fall, making the grid voltage of V_1 less negative, with the result that potentials e_3 and e_2 will fall, owing to the increase in anode current. The grid potential of valve V_2 thus becomes less negative and that of V_3 more negative. The anode current of V_2 will increase to bring about conduction of thyratron V_7 earlier in the cycle, while at the same time the increase in the anode current of V_3 will result in the grid voltage of thyratron V_8 becoming fully retarded.. The pilot motor then runs in the appropriate direction to restore the speed of the main motor to normal. It will be noted that the pilot motor armature voltage, and hence its speed, is approximately proportional to the error voltage $e_i - e_0$.

By the same reasoning it can be shown that a rise in speed of the main motor, due to a reduction in load, will bring about a decrease in the grid voltage of V_2 and an increase in that of V_3 with the result that the pilot motor will rotate in the opposite direction to restore the speed of the main motor to normal.

Two major factors contribute to the satisfactory operation of regulators of this type:—

(*a*) A satisfactory design of tachometer generator and its drive. Cyclic variations in generated voltage must be reduced to a fraction of the required speed regulation if high accuracy is required. Cyclic variations in voltage can be produced in the tacho-generator itself by variations in the air gap and by "grain ripple," all of which can be reduced to negligible proportions. Direct drive between the controlled shaft and the tacho shaft is desirable, but if a gearbox is required, then accurately cut gears are essential.

(*b*) In the a.c. commutator motor limitation of backlash in the gearbox and in the brush gear itself is of prime importance.

† *Ibid.*

‡ *Ibid.*

British Non-Ferrous Metals Research Association

FOLLOWING the annual general meeting of the British Non-Ferrous Metals Association on Thursday of last week, July 10th, the laboratories at Euston Street, London, N.W.1, were opened for inspection by representatives of members. The occasion was one of particular interest, for in addition to the opportunity presented of seeing the work in hand, visitors were able to view the additional laboratory accommodation which is just becoming available. This extra space is some 17,000 square feet.

It may be recalled that before the war the Association's laboratories consisted of two blocks, each of four stories and basement, with a metal melting shop between them. In 1940 one of the blocks was completely destroyed by fire. Adjacent property in Euston Buildings was subsequently bought by the Council, and work has been carried out since 1945 in adapting it for use. Work is now virtually complete on part of these buildings and the remainder will, it is expected, be ready for use in a year's time. The new accommodation which has already been brought into use has, of course, considerably reduced the difficulties under which the Association has been working.

A tour of the buildings revealed much that was of interest. In particular, it was noted that a newly installed Metropolitan-Vickers electron microscope was being put to good use for metallurgical research. The high-tension electrical supply for the microscope is also suitable for an electron diffraction camera, being made in the Association's workshops. A variety of problems has already been encountered where an electron diffraction camera would have been useful if the facilities had been readily available.

METAL FINISHING RESEARCH

The Council and Research Board have decided to establish a metal finishing research section and the laboratory extensions will provide facilities for electrodeposition research on the "beaker" scale as well as for a wide variety of experimental work on a scale more nearly comparable with industrial practice. To ensure that the research programme undertaken would meet the needs of the members who are interested in metal finishing, the Research Board arranged for a conference to be held. Altogether over thirty member firms were represented at this conference and an interesting and vigorous discussion took place, as a result of which a number of specific recommendations were made to the Research Board on the importance of different items of research. It was quite clear at the conference that there is a real need for improved research facilities for work of the kind now envisaged and that many members of the Association are deeply interested in metal finishing problems.

CORROSION IN CONDENSER SYSTEMS

Further tests on the "jet" apparatus using sea water of varying degrees of contamination have confirmed that the copper-nickel-iron alloys developed by the Association give excellent resistance to attack by fast-moving aerated sea water. Present work is mainly concerned with the best conditions for use of these materials with particular reference to the effects of the complicated structural changes which result from heat treatment.

The relative corrosiveness of different samples of sea water used in this work continues to be assessed by the "copper corrosion index." This test has been further improved and is considered to be a reliable guide to the degree of contamination of a given sample of sea water.

NEW RESEARCHES

The Research Board and its Industrial Research Committees have given much thought to the expansion of the research programme and, after careful consideration of the large number of suggestions which they had received, have initiated eight new researches. Most of them are aimed at the solution of practical problems by elucidating the underlying scientific principles, and therefore come within the category of objective fundamental research which is considered by many to be the rightful sphere of the Research Associations.

BASIC RESEARCHES

The Association has continued its contributions to the cost of the researches on deep drawing and on rolling for which the Motor Industries Research Association and the British Iron and Steel Research Association respectively accept the main responsibility. Reports have been issued to members describing some practical aspects of deep drawing of metal cups as well as some of the theoretical considerations involved. A comprehensive report on the work on rolling carried out on the Sheffield experimental mill has been made

available to members, and a development report summarising Orowan's theory of rolling has been prepared by the Association's staff.

Metal Finishing

Provision of special laboratory facilities for metal finishing research has been delayed owing to building difficulties, but a licence has been obtained and the work will be pushed forward as rapidly as possible. A conference of interested members has been held and recommendations made to the Research Board as to the priorities which the industry would like given to various research projects.

Pressure Welding

In the work on the pressure welding of light alloy sheet and bar, it has been found that in certain cases satisfactory welds are more easily produced by the use of clad materials. It has also been found that the pressure welding of high purity aluminium is possible at room temperature and this may have important practical applications. Preliminary work has been carried out on the pressure welding of zinc and of deoxidised arsenical copper sheet. The welding of zinc has proved difficult due to the type of oxide film normally present, but metallurgically perfect joints can be obtained in copper sheet, provided the deformation and temperature employed are sufficiently high.

Thames Flood Control*

Stated simply, so far as the Thames is concerned, if a flow of 5000 m.g.d. measured at Teddington (reduced, of course, proportionately as the area draining to the river decreases) be taken as the maximum flow that can be contained in the river without overflow, it follows that to similarly contain a flow of, say, 15,000 m.g.d., which is probably the peak flow ever likely to be experienced, two more rivers, each approximately equal to the present capacity of the Thames, would have to be created throughout its length. To do so, works of enormous magnitude and cost would be required.

The form that flood control works would take has been the subject of thought and discussion by civil engineers over a long period of years. Broadly speaking, there are three kinds of methods that can be employed. They are :—

(1) Reservoir projects.
(2) Embankments.
(3) River channel and weir improvements.

In essence, controlling flooding by reservoirs is a system in which unwanted flow is stored and then passed back into the river at such a rate as will permit this without overflow. The type of reservoir employed is either the artificial basin formed by a water-tight embankment constructed round the rim, or the artificial lake formed by constructing a dam across a river valley.

The capacity required to bring about the desired object would be some 160,000 million gallons, which is equivalent to about twenty-four reservoirs similar in size to the Metropolitan Water Board's Queen Mary reservoir at Littleton, Middlesex. At prices ruling to-day, such a scheme would cost about £78,000,000.

Quite apart from the very high cost of such a scheme, the effect would be to flood or otherwise sterilise, more or less permanently, nearly 17,000 acres of land, for the most part agricultural; in addition, by damming the river valleys, roads, railways, villages and dwelling-houses would be submerged. Moreover, sites suitable for the basin type of reservoirs do not exist.

To control flooding by embankments would involve embanking both banks of the river and its tributaries throughout their entire length. These embankments would result in a penning of land water behind them, which would have to be dealt with by an extensive system of arterial drains controlled by sluices. In point of fact, to treat a river like the Thames in this manner, whose life on either side has evolved gradually over a very long period of years and that has thereby reached a mature stability, is not now to be thought of.

The third method by means of widening the river, enlarging the weirs and making auxiliary channels where necessary, has already been discussed. It is the only practical method for controlling a Thames flood, but should it ever be carried out it must never be forgotten that the River Thames as known the world over would virtually disappear, its place being taken by a waterway of a widely different character. The cost of such a scheme between Teddington and Oxford would be of the order of £25,000,000.

The Method of Planned Zones

It will have been seen that there are various engineering ways and means of controlling a major flood in the Thames. Apart from cost, reservoirs and embankments are physically impossible for all practical purposes. The method of enlarging the river and the weirs is extremely expensive and destructive of most of the well-known river amenities.

In view of the above, the most practical solution of the problem is, in my opinion, to delineate a flood zone on either side of the river throughout its length, the tributaries being similarly dealt with later, if necessary. It will probably be found that except where the zone is intersected by a built-up area, no great harm or inconvenience is caused by flooding provided a warning system is in operation.

The built-up areas do, of course, present a complex problem, and one of some magnitude, amounting, as it must, to the eventual evacuation of people living therein and businesses located there. Nevertheless, when it comes to be examined in detail, it should not, in my opinion, prove an insuperable one. There is no doubt whatever that it would prove to be by far the cheapest method of any and would have the great merit of leaving the river and countryside alone.

* Extract from a Report on the Flooding of Urban and Agricultural Districts in the Thames Valley with Special Reference to the High Flood of March, 1947, by R.V.W. Stock, Chief Engineer, Thames Conservancy.

Canadian Engineering Notes

Conferences on Atomic Chemistry

Some of the secrets of atomic chemistry were revealed recently at a three-day conference at McMaster University, Hamilton, Ontario. The conference, one of three sponsored by the National Research Council to acquaint scientists with the broader aspects of discoveries at Chalk River, Ontario, where Canada's only atomic energy project is situated, paralleled a similar meeting for engineers at Toronoto and a conference for physicists at McGill University, Montreal. The meetings were part of the Canadian Government's policy of releasing results of nuclear experiments to the universities and diffusing a wider knowledge of nuclear science to help the creation of a pool of trained scientists with the basic knowledge in hand. Security reasons, however, forbade disclosure of much of the Chalk River work. The conference was highly technical and a few chemists admitted that some of the papers presented had baffled them. The delegates were told of the new fields in peacetime applications of radioactive tracers in industry, medicine, biology and agriculture and the uses, properties and handling of new elements, such as plutonium. But, as at the engineers' conference at Toronto, speakers warned of the terrible power unleashed by atomic fission.

Engineers Convention

The diamond jubilee convention of the Engineering Institute of Canada was recently conducted in Toronto. At one of the sessions, Gen. A. G. L. McNaughton, Chairman of Canada's Atomic Energy Control Board, reported that Canadian research into nuclear physics was towards the peacetime application of atomic energy. He said McGill, British Columbia and Saskatchewan Universities already had presented to the National Research Council plans for extensive researches in this new field. It was intended, he said, to grant 87,500 dollars to McGill, 32,500 dollars to the University of British Columbia, and 30,000 dollars to the University of Saskatchewan to put them in a position to undertake important research studies which could not now be carried out elsewhere in Canada. McGill already had erected a new laboratory in which a 100,000,000 electron volt cyclotron was being constructed. The grant to the University of Saskatchewan would go towards purchase of a 20,000,000 electron volt betatron. Mr. E. J. Wiggins, of the Chalk River Atomic Plant, told the convention that as much money was being spent on developing atomic energy for economic peacetime use as was spent on making it a weapon in wartime. He thought that Britain and the United States, where coal was used to generate electricity, offered greater possibilities than Canada, with its hydro facilities, for the conversion of atomic energy to peacetime power needs. Dean C. J. Mackenzie, President of the National Research Council, told the meeting that more than 10,000 young men were being trained in applied science in Canadian universities and that there were several hundred highly trained young Canadian engineers in Government and industrial research laboratories devoting their lives to fundamental and applied research.

Liquid Air Plant

The Canadian Liquid Air Company, Ltd., Montreal, producer of industrial gases for welding, cutting and other purposes, has announced that the company will begin construction of an oxygen and acetylene plant at Edmonton, Alberta, as soon as building materials can be secured. The company at present operates fourteen gas producing plants, extending from the Atlantic to the Pacific, three of which were built during the war and two since the war ended.

Lorne A. Campbell

Mr. Lorne A. Campbell, president and managing director of the West Kootenay Power and Light Company, died recently at his home in Rossland, British Columbia. He was in his 77th year. Mr. Campbell had been closely associated with the engineering and industrial development of British Columbia for the past fifty years, and it was he who conceived and initiated the production of electrical power on the Kootenay River, eventually building one of the most important and largest hydro-electric power companies in Canada. He was also a director of the Consolidated Mining and Smelting Company of Canada, Limited.

Large Power Contract

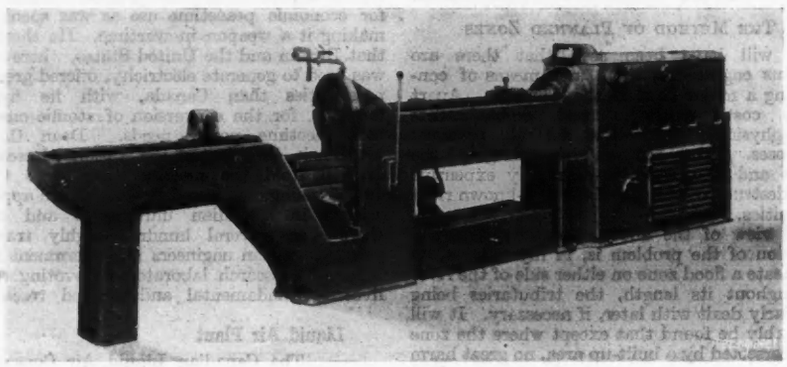
An 847,000 dollar contract has been awarded by British Columbia Power Corporation for a 62,000 h.p. generating unit for its Bridge River power project. This sum includes about 500,000 dollars for Vancouver Engineering Works, Ltd., a subsidiary of Vancouver Machinery Depot, Ltd., with the balance going to Canadian Westinghouse Company, Ltd. The Vancouver firm will build and assemble most of the turbine from designs by Pelton Waterwheel Company, of San Francisco, while Canadian Westinghouse will manufacture the 50,000-kVA generator. The unit will be the first of ten to be ultimately incorporated in the Bridge River project and will be the biggest of its type ever built for use in North America.

Women's Engineering Society.—At the Forum Club on Tuesday evening, July 15th, a dinner was given by the Women's Engineering Society to Dame Caroline Haslett, whom, we may recall, was created Dame of the British Empire in the 1947 Birthday Honours. Miss Haslett was wartime Chief Adviser to the Government on the training and employment of women, and has acted as chairman of the "Working Party" for the hosiery industry. She is also a member of the Labour Appointments Department Advisory Council, and British representative on the International Scientific Management Congress. A large company was present to welcome Dame Caroline, and it included many women occupying important positions in the British engineering industry.

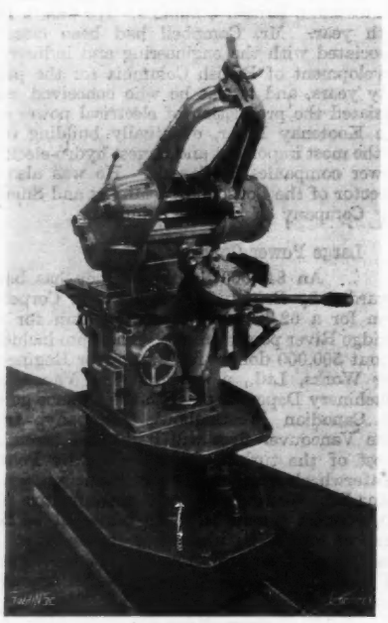
Two Swiss Machine Tools

INCLUDED in the range of machine tools made by the Swiss Industrial Society, of Neuhausen, are the milling cutter milling machine and the hydraulic broaching machine which we illustrate below.

The first machine is designed to cut teeth for both plain and form milling cutters from blanks up to 6in long and 7·87in diameter. The cutter head assembly of the machine is carried on compound slides on the top of a rigid base. The frame of the cutter head assembly, consisting of a driving motor, a gearbox and cutter spindle, is cast integral with a U-shaped arm projecting forwards over the machine. This assembly is carried on a large horizontal bearing and counterbalanced so that the arm projects upwards clear of the work when in a position of rest. When the arm is pulled down, the cutter on the spindle is brought into contact with the workpiece. A 1 h.p. motor drives the spindle through a change speed gearbox transmitting six speeds from 185 to 430 r.p.m.



HYDRAULIC BROACHING MACHINE



MILLING CUTTER MILLING MACHINE

The arm incorporates a shoulder yoke for the machine operator and the extent of its downwards movement, and thus the depth of cut is controlled by a roller on one side. This roller is arranged to come into contact with a template set on a bracket at the side of a dividing head on which the blank is fixed. The profile on the template is similar to that which it is required to reproduce on the teeth on the blank.

The dividing head is mounted in a vertical slide on the front of the machine base, and in order that various tooth forms and angles may be cut the head slide can be swivelled sideways. The head itself can be swung in a horizontal plane on its axis or through a limited vertical plane on its bearings, according to the tooth angle required.

When milling a blank the operator maintains a constant pressure on the arm with his shoulder and left hand, and traverses the cutter across the blank by movement of the longitudinal head slide through a lever on the right of the machine. As the cutter passes across the work its path is controlled by the profile on the template, which, through the roller, raises and lowers the arm. After each successive tooth is milled, the blank is indexed to the next machining position by means of the dividing head.

The horizontal hydraulic broaching machine is designed to exert a maximum pull of 15 tons at variable speeds up to 18ft per minute. It has a working stroke of 50in and takes internal broaching tools up to 3in diameter. The draw and return speed is variable between 40ft and 100ft per minute.

A multiple screw hydraulic pump through which the draw rod is actuated is totally enclosed within the body of the machine, together with its 13 h.p. driving motor and control gear. A hand wheel operated control valve is used to preset the pulling effort required on the broach. The actual force exerted during the working stroke is clearly shown on a large indicator set on the head of the machine. Constant control of the draw rod during broaching is maintained through a hand lever at the working position, and the length of stroke is set by means of two adjustable stops. Two interchangeable tool-clamping devices are provided for the end of the draw rod and each is designed to disengage the tool automatically at the end of the working stroke.

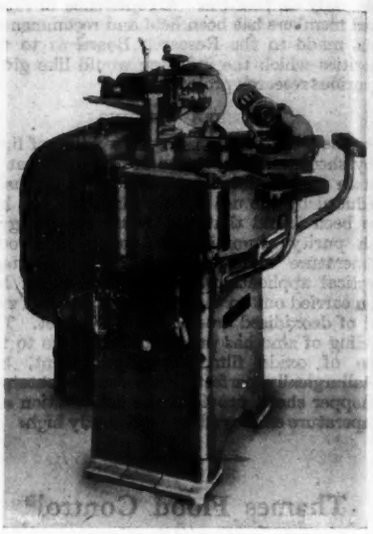
The machine is designed for both internal and external broaching. Work can be held either on a vertical face plate or on an adjustable table, which is movable on machined slides in the frame below the face plate. The trailing end of the broach is supported in a carrier which slides freely along the ways of a drop tray extending beyond the face plate.

We understand that Dowding and Doll, Ltd., has been appointed agent in this country for these machines.

A Milling Cutter Grinder

A CUTTER sharpening machine developed by Fabrique de Machines-Outils Oerlikon Buehrle et Cie, Zurich-Oerlikon, Switzerland, is designed to grind the lands of milling cutters without necessity for touching the original rake angle. This machine can be operated by semi-skilled labour and on it practically any type of toothed cutter of straight or profiled form can be sharpened. The general arrangement of the machine and the method of operation can be seen in the photographs which we reproduce.

The grinding wheel spindle, which is belt-driven from an enclosed motor at the rear of the column, has three speeds, 2730, 3290 and 3980 r.p.m. The spindle assembly incorporates a vertical adjustment of about 1¾in in order that the wheel can be set according to the clearance angle required on the cutter teeth.



CUTTER GRINDER

It also has a horizontal adjustment of about 1¾in.

The work table is designed to accommodate cutters up to some 6¾in diameter and 6¾in long, its workheads being arranged to hold the work between centres, in collets or in Morse tapered sleeves. As can be seen, this table swings freely on four heavy links. It is designed to position the work in respect to the grinding wheel through a template conforming to the profile of the cutter. This template contacts a roller below the centre of the grinding wheel, and is mounted in a slide set in the table. The template can be moved in two planes in respect to the axis of the cutter being sharpened, and its adjustment controls the depth of grinding on the lands of the cutter teeth.

GRINDING PROFILE CUTTER

During the grinding operation the operator rests his forearms on two padded arms, and maintains a constant pressure of the template against the guide roller as each tooth of the cutter is moved in turn along the wheel. Grinding dust is prevented from falling and

fouling the template and roller by means of a dust chute below. This chute is coupled to an exhauster at the back of the machine.

A Foundry Training Scheme

In furtherance of its policy for the comprehensive training of apprentices the Stanton Ironworks Company, Ltd., near Nottingham, has recently opened a new fully equipped training centre. This centre comprises a foundry, an engineering shop and a woodwork department, each of which is under the supervision of full-time instructors, who have had wide experience in their respective branches of industry.

The foundry training section of the centre, a corner of which is shown above, is a complete foundry unit, the equipment of which is designed to instil into the boys the fundamental principles of good foundry practice. In this department the only mechanical aids are a sand preparation and handling plant. This plant comprises a knock-out grid with conveyor belt and magnetic separator for the return sand, which passes through a rotary screen before being elevated to the storage bunker. Dust from the sand preparation plant is removed by a dust extraction plant. For sand mixing there is a sand mill equipped with an overhead batch loader and a bucket loader. A stationary sand dryer and a sand mixer are used to prepare the oil sand required in the centre.

Cores and moulds are dried in a brick-built core stove, designed to permit the taking of sample gases and temperatures at various points. Cores and moulds are handled by an elevating truck complete with stillages.

The metal-melting plant includes a cupelette with charging platform and spark arrester, and an oil-fired tilting crucible for non-ferrous metals. For this plant the materials are stored in adjacent bins and are weighed on a portable platform weighing machine.

The foundry floor of approximately 2000 square feet is served by an overhead travelling crane with electric hoist blocks, and having hand control of long and cross travel.

Provision is made for vertical casting in a casting pit.

A gravity roller conveyor transfers moulding boxes to the knock-out grid which is situated in an enclosed knock-out bay. Fettling is carried out in an adjoining bay equipped with shot-blasting plant together with dust collector. In this bay are also a double-ended grinding machine and pneumatically operated chippers and grinders.

Apprentice patternmakers receive their basic training in the patternmaking department of the centre, and in order to develop craftsmanship the training is directed principally towards handwork.

The engineering and woodworking sections are fully equipped with the necessary machine and hand tools and in them the boys who are to become apprentices in the various trades will receive a comprehensive basic training. Those who enter employment in which apprenticeship is not involved, proceed to their future department after the first month of training. Such boys are then given an opportunity to return to the centre for handicraft instruction in order to stimulate an interest in the proper use of leisure.

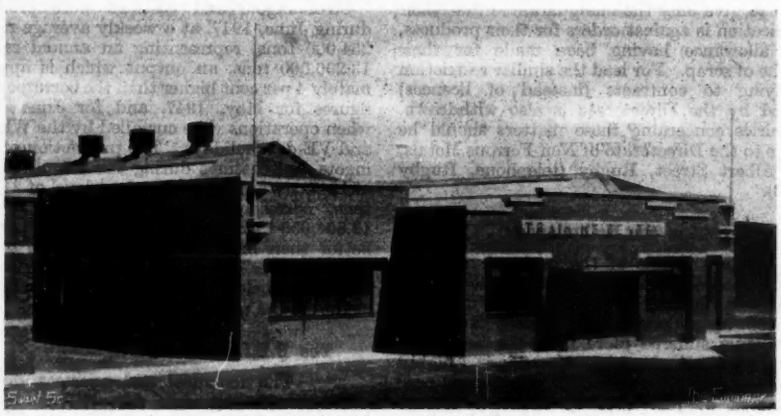
For theoretical training, the centre has a cinema and classrooms equipped with a film projector, epidiascope and other visual aids to instruction. A technical library is at the disposal of all apprentices and students.

The company appreciates that the transition from school life to industry has always been a difficult period in the life of the adolescent, and bearing this in mind the training syllabus has been designed to help during this period by a proper introduction to future employment. In order to foster the interest of the boys films and filmstrips produced by the company will be used to illustrate its own particular products and organisation and give recruits a knowledge of the firm, its products, processes and place in the industrial community.

Clothes lockers and shower baths provided in the centre will introduce the young workers to the conditions which prevail in the works. Physical training is also to be introduced into the syllabus of training, whilst the physical development of the boys will be under the observation of the firm's medical department. In building and organising this centre, the company aims to stress the importance of training, to interest and attract the future craftsmen, to equip them with a higher degree of skill, and to give the foundry technician a wider basis of knowledge and experience on which future developments of the industry can be built.

A SECTION OF THE FOUNDRY

APPRENTICES' CLASSROOM



THE STANTON IRONWORKS TRAINING CENTRE

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

MAGNESIUM ALLOYS: FORGINGS, PRESS FORGINGS AND STAMPINGS; SHEET AND STRIP; BARS AND SECTIONS

No. 1350–1357 : 1947. These specifications cover magnesium alloys in forgings, press forgings and stampings; sheet and strip; bars and sections; and tubes. Each of the four sections of the specification is complete, and contains clauses covering chemical composition, mechanical properties, and test requirements. This specification follows the publication in 1945 of British Standards 1272–1280 for magnesium alloy in the form of ingots and castings, and it is hoped to publish in due course a further specification for a series of alloys based on high-purity magnesium.

IGNITION AND LIGHTING UNITS FOR MOTOR CYCLES

No. 1368. This new British Standard deals only with the dimensions of combined dynamo and magneto units (double spindle type), combined generator and ignition units (single spindle type), combined dynamo and engine speed contact breaker unit and dynamos for use on motor cycles, having particular reference to those dimensions which affect the interchange of units. It sets out overall dimensions and fixing dimensions, sizes of tapers and keyways, and defines the position of the keyways on armature spindles. Tolerances applicable to those dimensions which affect interchangeability are included, and particulars of the gauges for use in connection with tapers are given in Appendices. Price 3s. 6d., post free.

Industrial and Labour Notes

Coal Output

Addressing the annual conference of the National Union of Mineworkers at Rothesay last week, Lord Hyndley, Chairman of the National Coal Board, said that, although he could speak with pride of some of the achievements of the coal industry in the first six months of national ownership, he was gravely perturbed by the strikes and falling production since the advent of the five-day week. The current weekly rate of output was about 100,000 tons less than it had been in the weeks immediately following the introduction of the five-day week. Lord Hyndley remarked that in the first four months of this year 241,000 tons of coal were lost through strikes, whereas in the two succeeding months, May and June, strikes resulted in the loss of 318,000 tons of coal.

Lord Hyndley affirmed that industrial discipline generally was good and that it was only a minority that was acting irresponsibly. Obsolete restrictive practices were interfering with the rapid reorganisation of tasks which was intended to procure a fair and full day's work; these attempts were greeted in many parts of the country with apathy and in some instances with resistance. The Board would be failing in its duty if it did not use every means at its disposal to safeguard the nation's coal supplies at this critical time and, Lord Hyndley continued, it was the Board's intention to deal rigorously with all flagrant cases of indiscipline.

Similar sentiments were expressed by Mr. Shinwell, Minister of Fuel and Power, when he addressed the annual conference. Mr. Shinwell restated his faith in the five-day week, and then spoke in condemnation of the 10 per cent minority of workers who were failing to pull their weight. In some parts of the country there seemed to be a lack of the tremendous economic and social issues involved, to say nothing of the political issues at stake. Drastic measures would be used, if necessary; where men refused to obey injunctions and where production was adversely affected and the nation held to ransom it might be necessary, though it would be deplorable, to have to close one or two of the pits that were concerned.

Scotland's Development Areas

The Board of Trade Journal dated July 5, 1947, contains the third article in a series on "Development Areas To-day." Previous articles in this series dealt with South Wales (June 21st) and the North-East Coast (June 28th), and the third article gives an account of progress made since the end of the war in achieving a balanced industrial structure in Scotland. In the past, industrial Scotland, centred around Glasgow, has been dominated by shipbuilding, coal mining and heavy engineering with results that are only too well known. To-day the area is experiencing an industrial revival which is based on the introduction of new trades and industries.

A survey of the progress made in the Scottish Development Area since the end of hostilities in Europe shows that of the 336 major schemes approved, sixty-one new factories or extensions of more than 5000 square feet have been so far completed as to be ready for occupation. This figure excludes sixty unallocated "advance" factories, eighty minor projects and many scores of adaptations. Most of the factories that have been completed are getting into their stride, producing refrigerators, vacuum cleaners, electrical and radio equipment, clothing, household goods, plastic articles, materials for housing, and a wide variety of other products. More than half of the 336 new factories and extensions have been financed by the Government. The remaining 155 projects, of which 55 were new and 100 were extensions, were privately financed.

The story of the Government-financed works is very largely the story of the extension of the industrial estates which are managed by Scottish Industrial Estates, Ltd., a non-profit-making enterprise which was established in 1937 and which even before the war had built many factories on estates in Lancashire and elsewhere. Now the company acts as agent for the Board of Trade in the construction, adaptation and management of the Board's industrial buildings in the development area. Post-war projects with which this company is concerned include the industrial estate in Dundee, five estates in the city of Glasgow and and twelve in the counties of Lanark, Renfrew, Dumbarton and Ayr.

Control of Non-Ferrous Metals

The Ministry of Supply has made the Control of Non-Ferrous Metals (No. 29) (Copper, Lead and Zinc) Order, 1947, which came into force on July 14, 1947. This Order further varies the Control of Non-Ferrous Metals (No. 22) (Copper, Lead and Zinc) Order; it reduces the maximum price of copper, increases the margin for black hot-rolled copper wire rods and provides for higher premiums on copper shapes. The maximum price for high-conductivity electrolytic copper is reduced by £5 per ton from £137 to £132 per ton delivered. Prices for other descriptions of copper are correspondingly adjusted, except in the case of black hot-rolled copper wire rods, where the new price is £138 per ton, against £142, and where the margin over the copper price is now £6 per ton in place of £5. The reduction in the copper price reflects the lower price at which the Ministry is now buying copper overseas. The premiums on a variety of copper shapes are increased by varying amounts of between 15s. and £1 10s. per ton to bring them more into line with the Ministry's costs. Some shapes not hitherto covered by Order are also listed. The Order also authorises the performance of pre-Order contracts at the old prices. Copies of the Order may be obtained from His Majesty's Stationery Office, York House, Kingsway, London, W.C.2, or through any bookseller, price 1d (S.R. & O. No. 1447, 1947).

The Ministry of Supply has also announced the withdrawal of the restriction whereby the issue of licences for copper, zinc and tin metal, as supplied by the Directorate of Non-Ferrous Metals, was limited in accordance with the applicant's rate of consumption, stock and forward purchases. Thus, applicants for licences (and contracts) for these metals will, in future, need to give only the one guarantee that their application is against orders for their products, full allowance having been made for their intake of scrap. For lead the similar restriction applying to contracts (instead of licences) issued by the Directorate is also withdrawn. Inquiries concerning these matters should be made to the Directorate of Non-Ferrous Metals, 20, Albert Street, Rugby (telephone, Rugby 2132).

Recovery in the Netherlands

An outline of the economic position of the Netherlands is given in an article appearing in *The Board of Trade Journal* of June 21st. No country amongst our Western European neighbours suffered more from the impact of war than did the Netherlands. She is a highly developed country with a population now estimated at just over 9½ millions. Before the war 19½ per cent of her population were engaged in agriculture, 38 per cent in industry, 13½ per cent in commerce, 10 per cent in transport, and the remainder in miscellaneous occupations. For her industry and agriculture she largely depended upon imports of raw materials, fertilisers and food. There was a deficit in her visible foreign trade, but the gap was filled by her extensive *entrepôt* and transit trade, her flourishing mercantile marine and overseas investments.

Liberation was, for the Netherlands, a slow process, and recovery was hindered by physical damage to the soil, factories and transport system, by the depletion of her livestock, and by the loss of trade with her Far Eastern possessions and with Germany, her principal supplier. The country's internal transport system has been largely rehabilitated, but there remains a shortage of rolling stock. Coal output has been handicapped by shortage of labour and there has been difficulty in replacing the foreign labour that was withdrawn by the occupying power. However, coal output has been restored to two-thirds of the pre-war figure of 12 million tons, and in spite of the fuel shortage export of coke has been resumed. Iron and steel mills are working at more than their pre-war capacity. Metal industries generally have reached or are near their pre-war output levels, except that tubes, wire and sheet metal are in short supply. Similar shortages affect shipbuilding and other manufacturing industries.

The Dutch mercantile marine is being rapidly restored and is expected to attain 80 per cent of pre-war capacity this year. Holland's *entrepôt* trade, however, is much below the pre-war level. In the country's present financial position priority in imports is given to essential raw materials and capital equipment; these items accounted for 50 per cent and 21 per cent of the value of Holland's imports in 1946, consumer goods accounting for only 15 per cent. Nevertheless, the Dutch are anxious that this policy should not permanently restrict the entry of those British manufactured goods that traditionally found a market in the Netherlands.

Iron and Steel Production

Information published recently about the production of iron and steel in the United Kingdom in June shows that the upward trend in the output of pig iron and steel ingots and castings has been maintained. The production of pig iron during June averaged 144,000 tons, which is 2000 tons more than the weekly output in May and corresponds to an annual rate of 7,501,000 tons, whereas the annual rate in June, 1946, was 7,878,000 tons. In the second quarter of 1947 the output averaged 142,000 tons weekly, representing an annual rate of 7,363,000 tons, which was an improvement on the figures for the first quarter but was substantially below the corresponding figures for the second quarter of 1946 (151,000 tons weekly average, 7,827,000 tons annually).

Steel ingots and castings were produced during June, 1947, at a weekly average rate of 254,000 tons, representing an annual rate of 13,206,000 tons, an output which is approximately 4 per cent higher than the corresponding figures for May, 1947. and for June, 1946, when operations were curtailed by the Whitsun and VE-day holidays. The production of steel ingots and castings during the second quarter of 1947 was at a weekly average level of 244,000 tons, corresponding to an annual rate of 12,694,000 tons, which was roughly 12 per cent better than in the first three months of this year, but was at the same time approximately 3 per cent below the average output achieved in the second quarter of 1946.

The B.E.A. and Exports

The technical and overseas division of the British Engineers' Association is making a post-war check on the requirements of overseas buyers of United Kingdom engineering products. The B.E.A. says that it is showing encouraging results and that a mass of useful and up-to-date information regarding the export market is being accumulated.

More than 4000 overseas firms on the Association's records have been circularised, and, apart from general particulars, have been asked to say which United Kingdom firms they now represent, the specialties they handle, and any other items in which they propose to seek representation. To date, the results show approximately an 80 per cent response to the survey, which covers eighty-three countries, and is expected to be completed by the end of August.

French Engineering News

(From our French Correspondent)

PARIS, July 11th.

The Loire and Gard thermal generating stations, now under construction, will consume exclusively poor quality pulverised fuel in specially adapted boilers. This is yet another effort to economise in the consumption of good-quality coal, which can be turned over to industrial use.

* * *

Orders for rolling stock placed in France by the S.N.C.F., up to April, 1947, include: seventy-two steam locomotives, eighty tenders, thirty-five electric locomotives, seventy-four railcars, one railcar trailer, 350 main line carriages, 3900 tipping wagons and 320 semi-trailers for road or rail. Orders placed abroad include seventy diesel-electric 600 h.p. locomotives, 26,750 covered wagons, 16,000 tipping wagons, one snow plough locomotive. Rolling stock so far delivered includes 1303 steam locomotives, 171 tenders, 23 electric locomotives, 62 diesel locomotives, and 8 railcars.

* * *

French automobile production is to-day only 50 per cent that of pre-war, and only 6000 new vehicles were sold in France during 1946. This is mainly due to shortages of coal and ferrous metals, and also to the Government's decision that railways must take precedence. In 1938 the automobile industry absorbed 465,000 tons of ferrous metals, while this year it will only receive 284,000 tons. On the other hand, the S.N.C.F., which used 400,000 tons, has been allocated an extra 300,000 tons this year, and will also profit from imports to the extent of 600,000 tons. Only 7 per cent of the total ferrous metal production is reserved for the automobile industry, compared with 15 per cent to 18 per cent in America and 11 per cent to 13 per cent in England. For the first quarter of 1947, production in France was 36,622 vehicles, against 63,800 in England and 1,500,000 in America. However, production is rising steadily, with emphasis on industrial vehicles. Fourteen different prototypes are being produced, against sixty-five in England.

* * *

Replying to a question in the Assembly as to the quality of coal which sometimes contains up to 50 per cent stone and does not permit uniform pressure to be maintained in boilers, the Minister of Production stated that reductions in American imports had affected the quantity, while quality was lowered following the prolonged bad weather which held up the working of washing machines. Since good quality coal had to be reserved for priority services other industries could only receive reduced tonnages, and in order to keep them going poor quality coal was included. In spite of larger imports, quality was likely to remain poorer than pre-war owing to shortage of labour in the mines, necessity to exploit poor seams, development of mechanisation, which reduces hand sorting, and reduction of capacity of washing installations due to destruction of many important units. The situation would be improved as washing was modernised and new machines brought into use.

* * *

It has been suggested by the president of the Association Nationale des Usagers des Petites Forces Hydrauliques that the 30,000 small waterfalls existing in France might be used to supply additional electricity in view of the fact that consumption demands are likely to exceed production for some time yet. Power from this source would be most abundant in winter, just at a time when general networks are in most need. Some of these falls already supply power for local mills, paper works and workshops. But often the industry using the fall only draws on the supply necessary to provide its own needs, and these falls could be used to produce more, the excess going to general electric networks. In such cases power could be obtained with a minimum of expense, for dams already exist, and it would suffice to install a turbine and alternator.

Notes and Memoranda

Rail and Road

EXHIBITION OF SOME NEW RAILWAY MODELS AT PADDINGTON.—Some very fine working models which have been presented to the directors of the Great Western Railway Company by the maker, Mr. B. R. Hunt, of Johannesburg, are now on show at Paddington Station. These models, which took some twelve years to make, include the "Cornish Riviera Express" coach drawn by the engine "King George V" and George Stephenson's "Locomotive No. 1" with the first closed carriage "Experiment."

BETTER STATION SIGNS FOR G.W.R. STATIONS.—As part of its public relations activities the G.W.R. has for some months past been studying the visual appearance of its stations. As a result new station nameboards will be on a red and white background; they will be placed at eye level and will be spaced along the platforms about a carriage length apart; easily read lettering will be used for station nameboards; direction signs will be better and more numerous, designed both to help passengers and ease the work of station staffs—they will be of the easily cleaned type.

BROMPTON ROAD, WESTMINSTER.—At a recent meeting of the London County Council the Town Planning Committee approved in principle a proposal to widen a section of Brompton Road, near the north-east end, to 90ft, which would provide a carriageway of 60ft and two footways each 15ft wide. Legislation for compulsory acquisition of land was recommended. Brompton Road is used by a considerable volume of traffic, which is likely to increase when the Cromwell Road extension is completed. Widenings have already been carried out in the narrower parts when opportunity occurred. The improvement now proposed will affect a considerable length of Brompton Road and will remove a bottleneck on this important route. An estimate of the total cost is £274,000.

LECTURE COURSES AT THE ROAD RESEARCH LABORATORY.—During the autumn and winter of 1946–47, lecture courses were given at the Road Research Laboratory, Harmondsworth, with the purpose of bringing the latest results of Highway Research before practising road engineers. The number of applications for places at these courses considerably exceeded the available accommodation, and it has been decided to repeat the lectures during the coming winter season. Each course will be divided into three self-contained sections, dealing, respectively, with soil mechanics, concrete, and the use of tar and bitumen in road construction. Each section will last from two to three weeks, the lectures being supplemented by practical work and by visits to actual road and road works in progress. Lectures will be given on the following dates: Soil mechanics, October 8th to October 24th, December 3rd to December 19th, February 4th to February 20th; concrete, October 27th to November 7th, December 29th to January 9th, February 23rd to March 5th; tar and bitumen, November 10th to November 26th, January 12th to January 28th, March 8th to March 24th. Further particulars and forms of application can be obtained from the Director, Road Research Laboratory, Harmondsworth, Middlesex.

Air and Water

THE "FLOATING EXHIBITION."—It is stated that the first post-war British "Floating Exhibition" during its tour of South American ports was seen by more than 20,000 visitors, and orders for nearly one million pounds worth of goods were placed. The exhibition was staged on the 9500-ton motor cargo liner "St. Merriel."

SHIPBUILDING IN INDIA.—According to the Bombay correspondent of *The Times*, a shipbuilding yard to construct ocean-going vessels of 10,000 to 15,000 tons is to be established at Karachi. The cost of the new yard is estimated at £3,750,000. The Karachi Port Trust has leased land for the new yard for ninety-nine years.

RADAR FOR MERCHANT SHIPS.—Some particulars of the radar system known as "Seascan," which was developed for use as a navigational aid in merchant ships, are contained in two descriptive leaflets (651/2-1 and 651/1-3) published recently by Metropolitan-Vickers Electrical Company, Ltd., the makers of the equipment. "Seascan" radar sets have already been installed in a number of merchant ships, and this is the system selected for installation in R.M.S. "Queen Mary." In THE ENGINEER, June 28, 1946, we published a short account describing a working demonstration of the system.

Miscellanea

A HANDBOOK OF EXPORT PROCEDURE.—The Engineering Industries Association of 9, Seymour Street, London, W.1, has published a little book entitled "Export" to assist manufacturers engaged in or about to commence export. It gives advice and guidance on products, markets, publicity, and sources of authoritative information. Copies of the booklet can be obtained at the Association's offices for 3s. 6d, net.

THE WHITWORTH SOCIETY.—The Whitworth Society is holding a reception and luncheon on Wednesday, July 30, 1947, at the Holborn Restaurant, at 12.30 for 1 p.m. This function, according to custom, is limited to Whitworth Scholars, Exhibitioners and Prizemen. During the luncheon Mr. Leslie H. Hounsfield, A.R.C.S., M.I.Mech.E., Wh.Ex., will retire from the presidential chair and will install as his successor Professor Andrew Robertson, F.R.S., P.P.I.Mech.E., Wh.Ex.

THE NATIONAL JOINT INDUSTRIAL COUNCIL FOR THE DREDGING INDUSTRY.—The first meeting of the newly formed National Joint Industrial Council for the Dredging Industry was held on Tuesday, July 8th, in London. The constitution having been duly adopted, Mr. C. C. Gover, Chairman of the Federation of Dredging Contractors, was appointed Chairman, and Mr. Arthur Bird, National Secretary of the Transport and General Workers' Union, Vice-Chairman. The Council considered proposals for a new national agreement for the industry, and the Council now stands adjourned for each side to consider further the proposals.

SPECIAL LIBRARIANSHIP.—A study group on special librarianship has been organised by Aslib in co-operation with the Library Association, to be held at Chaucer House, Malet Place, London, W.C.1, during the week of August 11-16, 1947. Talks will be given to the students in the mornings, covering such subjects as the librarian in the special library, the work of the National Central Library, foreign bibliographical information, Government libraries and national and international organisations connected with library work. The afternoons will be devoted to visits to a number of special libraries, and there will be informal lectures on three evenings on classification systems, bibliographical work and the work of an information officer. A detailed programme and application forms can be obtained from the Aslib office, 52, Bloomsbury Street, W.C.1, and students are asked to apply as soon as possible as numbers will be limited.

COURSES IN ILLUMINATING ENGINEERING.—Two courses in illuminating engineering have been arranged to take place in London from September, 1947, to May, 1948: one at the Northampton Polytechnic on Wednesday afternoons and evenings and the other at the Borough Polytechnic on Thursday afternoons and evenings. These courses, which will be considerably shorter than the normal full-time courses previously arranged, will nevertheless prepare candidates for the City and Guilds intermediate examination in illuminating engineering. Intending candidates should communicate with the Polytechnic concerned. A similar course will commence in September, 1947, at the Central Technical College, Birmingham, and other courses are in prospect at Cardiff, Leeds, Liverpool, and Manchester, particulars of which will be obtainable from the Illuminating Engineering Society, 32, Victoria Street, London, S.W.1, in due course.

MOND NICKEL FELLOWSHIPS.—In February, 1946, the Mond Nickel Company, Ltd., offered to make available, over a number of years, the sum of £50,000 for awarding annually "Mond Nickel Fellowships." The co-operation of several learned societies was sought and readily promised in awarding and administering the fellowships. The Fellowships will be awarded to persons of British Nationality educated to University degree or similar standard, though they need not necessarily be qualified in metallurgy. There are no age limits, though awards will seldom be made to persons over 35 years of age, and each Fellowship will occupy one full working year. It is proposed to award up to five Fellowships each year of an average value of £750. The Fellowships will be awarded to selected candidates who wish to undergo a programme of training in industrial establishments and will normally take the form of travelling Fellowships; awards for training at Universities may, however, be made in special circumstances. Full particulars and the necessary forms of application can be obtained from the Secretary, Mond Nickel Fellowships Committee, 4, Grosvenor Gardens, London, S.W.1. Completed application forms will be required to reach the Secretary of the Committee not later than September 1st.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chemical Society.

Thursday, July 17th, to Thursday, July 24th.—Eleventh International Congress of Pure and Applied Chemistry in London.

Engineering and Marine Exhibition

Thursday, August 28th, to Saturday, September 13th.—London, Olympia.

Institute of Physics

Friday and Saturday, July 18th and 19th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. Symposium on "Methods of Crack Detection."

Institution of Electrical Engineers

Saturday, July 26th.—N. MIDLAND STUDENTS: Summer Outing. 9 a.m.

Institution of Naval Architects

Tuesday, September 23rd, to Friday, September 26th.—Autumn meetings at Portsmouth and Southampton.

Iron and Steel Institute

To-day, July 18th.—Summer meeting in Switzerland.

Public Works Congress and Exhibition

Monday, July 21st, to Saturday, July 26th.—London, Olympia.

Stephenson Locomotive Society

Sunday, July 20th.—NORTHERN BRANCH: Visit to Hull Running Sheds, L.N.E.R. 2.30 p.m.

Thursday, July 24th.—Visit to Willesden Locomotive Depot, L.M.S.R. 6 p.m.

Personal and Business

THE GLACIER METAL COMPANY, LTD., has opened a Scottish factory at Kirkstile, Kilmarnock.

CRODA, LTD., announces that its London office is now at 24, Haymarket, S.W.1 (telephone, Whitehall 4725/6).

HADFIELDS, LTD., announce that Mr. E. W. Colbeck has been appointed metallurgical and research director.

MUIR MACHINE TOOLS, LTD., Britannia Works, Manchester, has taken the new title of David Brown Machine Tools, Ltd.

SIR FREDERICK LEGGETT, C.B., has been appointed chairman of the London and South-Eastern Regional Board for Industry.

THE BRITISH THOMSON-HOUSTON COMPANY, LTD., announces that Mr. Victor C. H. Creer has been appointed general manager of the lamp and lighting sales department.

DR. JOSEF WERNER BONDI, M.I. Mech. E., M.I.P.E., has been appointed a director of British Oil Engines (Export), Ltd., the export subsidiary of Associated British Oil Engines, Ltd.

THOMAS BUTLIN AND CO., Wellingborough, a branch of United Steel Companies, Ltd., has been bought by Morris Motors, Ltd., to provide potential capacity for tractors and similar types of iron castings production.

LLOYD'S REGISTER OF SHIPPING announces the following appointments:—Mr. Colin Bartlett, O.B.E., B.Sc., assistant to the chief ship surveyor, to be deputy chief surveyor (administration); Mr. W. J. Ferguson, M.Eng., principal surveyor on the chief engineer's staff, to be assistant chief engineer surveyor; Mr. J. Hodgson, principal surveyor for the Middlesbrough and Hartlepool districts, to be a principal surveyor on the chief ship surveyor's staff; Mr. H. R. Howells, senior surveyor at Manchester, to be principal surveyor for refrigeration on the chief engineer surveyor's staff, and Mr. H. N. Pemberton, a senior engineer surveyor, to be a principal surveyor on the chief engineer surveyor's staff.

Contracts

WILD-BARFIELD ELECTRIC FURNACES, Ltd., informs us that, together with its associated company, G.W.B. Electric Furnaces, Ltd., of Dudley, Worcs, the firm has obtained the contract for a complete heat-treatment plant for the motor-car manufacturing factory of the Hindustan Motors, Ltd., at Calcutta, where the "Hindustan" cars will be produced.

Launches and Trial Trips

MORBIHAN, motor cargo liner; built by Harland and Wolff, Ltd., for the French Government; length 420ft 6in, breadth 55ft, depth 33ft 6in; gross tonnage 4450. Engines, two-stroke, single-acting, crosshead type diesel, ten cylinders, 620mm bore by 1150mm stroke. Completed, July 2nd.

BOWGRAN, motor cargo line; built by Burntisland Shipbuilding Company, Ltd., for the A/S Nye Kristianborg, Norway; length 414ft., breadth 55ft 6in, depth 36ft; gross tonnage 4509. Engines, single-screw, Hawthorn-Doxford opposed-piston diesel of 4400 b.h.p., four cylinders, 670mm bore by 2320mm combined stroke. Trial completed, July 12th.

RIO SEGUNDO, motor vessel; built by Burntisland Shipbuilding Company, Ltd., for the Argentine State Shipping Company; length 425ft, breadth 57ft, depth 37ft 9in; 9400 tons deadweight. Engines, single-screw N.E.M. Doxford opposed-piston type diesel, airless injection, with four cylinders, 600mm bore by 2320mm stroke. Launch, July 2nd.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of Report.	Title.	Post free. s. d.
B.I.O.S.		
677	German Clock and Watch Dial Production	3 8
762	The Manufacture and Practical Application of German Synthetic Tanning Materials and Related Substances	10 3
764	Production of Aluminium Compounds in Germany	3 8
770	Further Developments in Dairying in Germany...	5 2
785	The German Mica Industry ...	5 8
809	German Dental Bur Industry: Production Statistics—August, 1945–August, 1946	1 1
835	Amalia, Bochum: Benzole Refinery	0 7
842	Synthetic Varnish Resins and Moulding Powders at Chemische Werke Albert, Wiesbaden ...	4 2
843	Manufacture of Ethyl Acetate from Acetaldehyde at I. G. Farbenindustrie, Hoechst ...	1 1
854	Deutsche Gold and Silver Scheideanstalt, Rheinfelden: Sodium Peroxide, Sodium Percarbonate and Sodium Perborate	1 7
855	Manufacture of Salt Cake, Sodium Sulphide and Sulphigran by I. G. at Leverkusen	1 7
F.I.A.T.		
174	Investigation of the New Wehrmacht (1944) Last and Shoe Construction	1 1
212	Quick Freezing of Foods in Liquid Nitrous Oxide: I. G. Farben at Hoechst	1 7
391	Study of New Adhesives Produced by I. G. Farbenindustrie A. G., Leverkusen...	1 7
419	The Rohn Low Frequency Induction Furnace	1 7
574	Flywheel Magnetos: R. Bosch G.m.b.H., Stuttgart	1 1
603	The 3·5 Litre, 8-cylinder, Air-Cooled, Automotive Engine of the Steyer-Daimler-Puch A. G.	2 7
741	Catalysts for Coal Hydrogenation	1 1
796	Vichromates Manufacture	5 2
804	Molybdate Orange Pigment ...	1 7
807	Litharge and Red Lead Process	2 1
809	Ferrocyanides and Sulphur from Gas Work Residues	1 7
811	Chrome Yellow and other Pigments at G. Siegle and Company	1 7
823	Utilisation of Blast Furnace Slag in Germany	3 2
825	Chlorine Dioxide and Sodium Chlorite at I. G. Farben, Griesheim	1 7
840	Gesellschaft fuer Linde's Eismaschine: Calculation of Regenerators for Linde-Frankl Installations and Overall Utilities Requirements for Linde-Frankl Oxygen Producing Unit	1 1
857	I.—Production of Acetic Acid at Burghausen and Knapsack II.—Concurrent Production of Acetic Acid and Acetic Anhydride at Knapsack	2 7
859	I.—Continuous Chilling and Cooling of Calcium Carbide II.—Acetylene Generation by Dry Type Generators III.—Purification and Drying of Acetylene for Chemical Use ...	2 7
861	Plasticisers for Poly-vinyl Chloride	2 7
864	The Manufacture of Hand Sewing Needles in Germany	2 7
XXXIII–49...	German Gas Welding and Cutting Industry	6 8
XXXIII–50...	Synthetic Fibre Developments in Germany (in four volumes) ...	55 11
B.I.O.S.:		
6	Report on a Visit to Munich Technical High School: Dr. Siegfried Windisch on Food Yeast	0 7
656	German Self-Adhesive Plaster and Tape Industry	3 8
717	The German Permanent Magnet Industry	3 2
779	Production of Seamless Metallic Pyrometer Sheaths and Electric Resistance Alloys by Hereaus Vacuumschmelze A.G., Hanau A.M. and at Sterbfritz	1 7
780	The Manufacture of Cigarettes, Cigars and Pipe Tobacco in Germany	1 7
781	Some German Synthetic Resin Moulding Plants and Processes	4 8
806	Investigation of the Methods Used by a Few Selected Firms of German Ball and Roller Bearing Manufacturers	1 1
811	Tetrachloroethane, Vinyl Chloride and Polyvinyl Chloride at Dr. Alexander Wacker: Gesellschaft fuer Electrochemische Industrie, Burghausen, Germany	2 8
815	Manufacture of Hydrazine Hydrate: I.G. Farben A.G. Leverkusen, Germany	0 7
817	Krupp-Lurgi Low-Temperature Carbonisation Plant at Krupp Treibstoffwerke, Manne-Eickel	1 1
834	Kohlenwertstoff Verbaende A.G. Bochum: Benzole and Tar Products Distribution	1 1
884	Ball Bearings: Notes on Production of Ball Tubing at Deutsche Edelstahlwerke A.G., Krefeld, and Production of Ball Races at Kugelfischer A.G., Schweinfurt	1 7
886	Manufacture of Hydrogen Peroxide	2 2
891	Ophthalmic Optical Industry in Germany (British and U.S. Zones)	2 1
900	German Armament Development Technique...	1 7
951	The Magnetophon Sound Recording and Reproducing System ...	10 3
F.I.A.T.:		
715	Ion Exchange, Coating and Plywood Resins at I.G. Farbenindustrie, Th. Goldschmidt A.G., Permutit A.G., and Chemische Werke Albert	5 2
723	German Carbon Bisulphide Manufacture	4 8
767	German Research on Zinc-Base Bearings	1 7
788	Aluminium Hydroxy Chloride Production at Ludwigshafen by Electrochemical and Chemical Methods	1 1
790	Production of Sodium Sulphide from Sodium Amalgam	1 1
799	Krupp-Renn and other Processes for Utilising Low-Grade Iron Ores in Germany	2 8
819	Metallic Sodium from Sodium Amalgam at Gersthofen	2 1
821	Zinc, Manganese and Other Metals Recovered by Amalgam Process at Duisburger Kupferhutte	2 2
830	English Translation of "Sodium in Germany and the Relations Between I.G. and Degussa in this Field"	2 1
852	English Translation of "N-Chloro-Amides of Higher Molecular Fatty Acids and their Conversion Products"	1 1
863	Activated Carbon Production at I.G. Farbenindustrie, Leverkusen	1 1
867	The Production of Mono-Vinyl Chloride	2 1
876	Continuous Casting of Metals in Germany	1 8
J.I.O.A.:		
42	German "Kunz Method" for Excavating Tunnels	3 2
48	German Airfield Design and Construction Methods	9 3

B.I.O.S. Information Section, 37, Bryanston Square, W.1., which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive inquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

Staggering of Working Hours

THE Minister of Labour, Mr. Isaacs, made a statement in Parliament on Tuesday last regarding the Government's plans for safeguarding next winter's supplies of power for industry. Explaining that the demand for electricity had risen by 70 per cent since 1939 and was still rising, he said that the situation required the adoption of drastic plans for spreading the industrial electricity load, and the loyal observance of those plans by industry. Various methods would have to be adopted, qut the whole country must understand that the problem of spreading the industrial electricity load was vital and urgent. Mr. Isaacs went on to say that the recent agreement made in the engineering industry (THE ENGINEER, July 4th and 11th) afforded a useful lead, and he had invited the British Employers' Confederation and the Trades Union Congress to draw the attention of their constituent organisations to it. He then announced that the Government had laid upon the Regional Boards for Industry and their district and other committees the complicated but vital task of working out plans to achieve the regional target of moving one-third of the peak load outside the normal daytime period. Those bodies, the Minister commented, on which both sides of industry were represented and with which the electricity supply undertakings and the Central Electricity Board were associated, had already achieved substantial results. Whilst the Government confidently relied on the wholehearted co-operation of everyone concerned in the matter, it could not disregard the possibility that there might be cases of unreasonable failure to operate approved schemes, and following the recommendation of the Joint Consultative Council, representing both sides of industry, it had been decided that compulsory powers must be used to deal with such cases. Once a case had been established, a direction would be issued under the Defence Regulations compelling the firm under penalty to reduce its maximum demand on the electrical supply to the required level. The district or other local committees of the Regional Board would bring such cases to notice, and the Regional Board would be required to satisfy itself that a case had in fact been established. Before action was taken, however, each case would be further examined by the Electricity Sub-Committee. It was the Government's hope, Mr. Isaacs concluded, that such powers would be required only very exceptionally. Questioned as to the Defence Regulation under which proceedings might be taken, Mr. Isaacs said that it was Defence Regulation 55 (2A) under which failure to observe a direction might result, in the event of a successful prosecution, in a penalty as high as £500 or one year's imprisonment. He made it clear, however, that this was only where there had been an unreasonable failure.

Employment of British Shipping

IN accordance with his policy of facilitating the return to the normal processes of shipping business, the Minister of Transport, Mr. Alfred Barnes, has arranged with the General Council of British Shipping that as from a date in the near future, the Council will take over certain executive work connected with the allocation of British ships to Government and Government-sponsored shipping requirements, hitherto undertaken by the Ministry of Transport. The Minister of Transport retains full responsibility for the fulfilment of the United Kingdom import and export requirements and for any other shipping programmes sponsored by H. M. Government, and will continue to exercise control of voyages by way of licence. Further, the Minister may, as under the existing agreed procedure, direct ships to particular employment. The new obligations undertaken by the shipping industry are, briefly, to see that within the limit of British shipping resources and by arrangement among British shipowners, sufficient tonnage of suitable type is made available to fulfil Government and Government-sponsored shipping requirements, while ensuring that British shipping resources are utilised to the utmost possible advantage in the national economy. In the provision of tramp tonnage on charter terms for bulk cargoes, the fullest possible use will be made of the normal commercial procedure, whereby owners make their fixtures through the customary chartering channels. All voyages will continue to be subject to approval and licence by the Ship Licensing Committee appointed by the Minister. The new arrangements will apply initially to the deep-sea dry cargo trades only, but at a later stage the practicability of applying similar arrangements to the coasting and short sea trades will be considered. The General Council will appoint a Shipping Advisory and Allocation Committee to assist them, and advise the Minister. It will be assisted by the Liner and Tramp Standing Committees and by an Executive Organisation.

The Economic Planning Board

THE first meeting of the Economic Planning Board was held on Monday last, and was addressed by the Lord President of the Council, Mr. Herbert Morrison. The Board's task, Mr. Morrison suggested, was to consider the economic situation as presented by the Government and as members might know it through their own experience; to offer an assessment of the economic situation, and to help the Government to keep in touch with industry's views on the situation and to make suggestions for action. In present conditions, the Lord President continued, industries required general guidance about their place in the national economy and the objectives they should set themselves. What was needed was that those who directed industry and those who operated the machines should make their contribution to the plan right from the start. It was impossible for a Government or a planning staff to plan in a void. Both needed a link with industry, a two-way link, and they looked to the Board to supply that need. The Board, Mr. Morrison asserted, should be the first to draw attention to difficulties occurring in industry, for the experience of its members in management and in the shops would enable it to make practical suggestions about the problems confronting industry, notably shortages of materials and fuel. The Board's subject matter, Mr. Morrison observed, would have two parts, short-term planning and long-term planning, the two being closely linked, because decisions taken on the short-term plan might have an important effect on the long-term plan.

Re-Opening of York Railway Museum

ON Friday, July 18th, Sir Ronald Matthews, the chairman of the London and North Eastern Railway Company, formally reopened the Railway Museum, in York, which has been closed throughout the war years. He was accompanied by Sir Geoffrey Kitson, chairman of the North Eastern Area Board, Sir W. H. Carver, and directors and officials of the railway company. Among the historic engines now again on view, are the Hetton colliery locomotive, built by George Stephenson; the famous "City of Truro," which held the record of 102 m.p.h. on the Great Western Railway; the Brighton Flyer "Gladstone," and the Stirling single driving wheel locomotive which formerly hauled the "Flying Scotsman." These engines were removed from the Queen Street Museum during the air raids and were sent to Sprouston, Tweedmouth, and elsewhere in the North. They have been cleaned and restored, and are now reassembled in their old surroundings. Sir Ronald, speaking of these superb examples of locomotive design, said that he had often wondered during the difficult war years how the harassed running superintendents had resisted the temptation to release them again for active service. The museum, which had started from small beginnings in the private collections of the late Mr. J. B. Harper, assistant superintendent, and Mr. Rudgard, assistant engineer, had now, rightly, become a national museum. He felt that the affection of the British people for the railways was founded upon a realisation that our industrial leadership was largely due to the companies' technical efficiency. The importance of the museum would, great as it was to-day, be enhanced by the changes in ownership and organisation which loomed ahead. The York Railway Museum would always stand as a record of the ingenuity and skill of the railway pioneers under private enterprise, which had laid the foundation of Britain's industrial greatness.

A Royal Society Reception

ONE of the greatest international scientific gatherings ever held in London took place at Burlington House, Piccadilly, on Thursday, July 17th, when the Fellows of the Royal Society held a reception on the occasion of the celebrations of the Centenary of the Chemical Society, and the meeting of the International Congress of Pure and Applied Chemistry. At the reception were also delegates of some twenty-five nations attending the meeting of the International Union of Chemistry and the International Physiological Congress. The guests were received by Sir Robert Robinson, the President of the Royal Society. For this great occasion the Royal Academy of Arts lent its galleries, and other scientific bodies, which have apartments in Burlington House, including the Chemical Society, the Linnean Society and the Geological Society, opened their rooms. In the library of the Royal Society were exhibits illustrating the contributions made to early chemical discoveries by Fellows, such as Robert Boyle, Joseph Priestly, and Michael Faraday. In the rooms of the Chemical Society, portraits were shown of distinguished chemists who had taken a leading part in the history of the Society during the hundred years of its existence, while the congratulatory addresses, fifty in number, presented to the Society on the occasion of its centenary were shown. The Linnean Society exhibited some of the rare specimens from the Linnaeus collection. In addition to these scientific exhibits, guests were able to view the 1947 Summer Exhibition in the galleries of the Royal Academy.

L.M.S. Express Train Derailment

A SERIOUS derailment took place on the London Midland and Scottish main line to the North on Monday, July 21st, when the 8.30 a.m. express from Euston to Manchester and Liverpool left the rails while travelling at speed through a cutting at Grendon, half a mile from Polesworth Station, near Tamworth. The locomotive and tender and fourteen of the sixteen coaches were derailed. The locomotive and tender as well as several of the coaches were overturned. The first two coaches formed a V across the four tracks and the seventh and eighth coaches took up a similar position. The train, which left Rugby half an hour before the accident, was derailed at 10.48 a.m., while entering a bend at the north end of the cutting. The track was torn up for a quarter of a mile and all four lines to the North were blocked, traffic being diverted to the North *viâ* Birmingham and Wolverhampton. We regret to state that five passengers died from their injuries and there were more than thirty passengers who were seriously injured. The driver and fireman escaped with shock and minor injuries; the fireman, who was firing at the time, was flung over and pinned down by coal from the tender. The driver was able to escape and give warning to a gang of platelayers working down the line, to stop all traffic. Happily, the train in the opposite direction, the 8.30 a.m. express from Manchester to Euston, which usually passes the express from London at this part of the line, was delayed at Lichfield.

Lighthouse Engineering

By K. C. SUTTON-JONES, Stud. Inst.C.E.

No. III—(*Continued from page 49, July 18th*)

IT is with reluctance that the engineer resorts to the adoption of the lightvessel. The geographical range of the light is limited by the comparatively small elevation given to the optical apparatus by the mast or light-tower. Furthermore, there is a risk of the vessel tearing from its anchorage, and the cost of maintenance is heavy. Only when the erection of a permanent lighthouse structure is deemed impracticable is the lightvessel resorted to—with exception in the case where a "landfall light" is required in the open sea. The Seven Stones Lightvessel off Land's End warns shipping of the presence of a group of jagged rocks upon which the erection of a permanent structure would be well-nigh impossible.

Lightvessels have to withstand the severest weather, notably off the south-west coasts of Great Britain and off the eastern coasts of the United States, where vessels are to be found moored many miles from the shore. The rolling motion of a vessel under weigh is often unpleasant, but to be tossed about at the end of a cable for months at a time demands both fortitude on the part of those aboard and a masterly touch of engineering skill on the part of those responsible for the design, construction and anchorage of such vessels.

It is incorrect to suppose that a lightvessel is any ordinary vessel adapted to carry a light. From keel to masthead it is unique and proudly displays the results of years of development on the part of lighthouse engineers. The vessels are "square," even "bulbous" in section and are usually rounded at the stem and stern. It is customary and necessary to construct lightvessels with at least two bilge keels in order to minimise the rolling. These keels may be anything up to 4ft wide and run for about two-thirds of the vessel's length.

Modern lightvessels range from about 130ft to 75ft in length, from 26ft to 21ft in beam and draw from 12ft to 6ft of water. In the past they have been largely of wooden construction; but, on account of the change in shipbuilding materials and technique, these are being replaced by iron and steel vessels, although these latter are not found to be as durable as the old wooden ones. Corrosion is a major problem with steel, and whilst there is a tendency for wood to develop dry rot this has been overcome to a considerable degree by the application of perchloride of mercury. Furthermore, whilst wooden vessels often remain on-station continuously for periods of seven years, it is found necessary to withdraw the steel vessels for overhaul about every three years and desirable as frequently as annually in the United States Lightservice. Frequent withdrawals are possible in this lightservice, however, since vessels proceed to and from their stations under their own propulsion. British lightvessels are not provided with means of self propulsion, although such means also serves the additional purpose of relieving the strain imposed on anchors and cables during rough weather.

In this article it is the intention to deal but generally with older types of lightvessel and to concentrate on more recent designs.

The old type of wooden vessel employed by the British Lightservices had a central mast some 40ft in height, which descended to the keel. The lantern containing a rotating assembly of oil lamps and parabolic reflectors was arranged around the mast and could be hoisted bodily up and down. This arrangement served well because the lantern could be lowered for attention and lamp trimming. The vessels were provided also with fog signalling devices, usually a siren or reed horn, principles of which are dealt with in the next article in this series.

A lightvessel's crew usually comprises up to eleven men—master, mate, engineer, cook and seamen, comfortable and warm accommodation for whom is essential. Engines and other machinery are situated amidships and it is customary to arrange the crew's quarters fore and aft. A major consideration is the positioning of the living quarters remote from the fog signal, since these signals can be a very real source of discomfort. The hull is divided into a number of separate compartments, maintained water-tight by bulkheads. This is made imperative in view of the ever-present danger of lightvessels being run down, especially during fog.

Most modern lightvessels have a central light tower and those in the United States Lightservice usually have two masts with lights carried on one or both. It is customary for one light to indicate the relative position of the vessel, it being of low power compared with the main light. Smaller lightvessels or lightboats have a central column, upon which the lantern and optic are supported, access being gained by means of a ladder fitted to the outside of the column. One type of tower for larger vessels contains two or three small rooms used for lookout purposes by those on watch and also for housing spares and through which a stairway passes to the lantern. This type is constructed of steel plates riveted together and passes through the decks to the keel, where it is specially supported. Additional external hawsers are employed to ensure its stability. In this manner lanterns of some 8ft in dameter may be supported, but it has been found that such towers have disadvantages. These include the objection of weight, of the fact that the tower obstructs the distribution of sound emitted by the fog signal, and the hazards involved in clambering up the stairways during rough weather. Furthermore, unless specially heated, the rooms within the tower become damp owing to condensation and afford little comfort to those on watch. Above all, the resistance to the wind and waves is such as to add to the movement of the vessel. The latest vessels have been equipped with openwork tower structures which moderate many of the above objections. One great advantage of this type of tower is that it can be supported from the main deck, thus dispensing with the need of carrying it through to the keel, leaving the engine-room unobstructed. The stability of the tower is increased by making the base wider than the top. Both angle iron and welded tubes have had application in the construction of such towers.

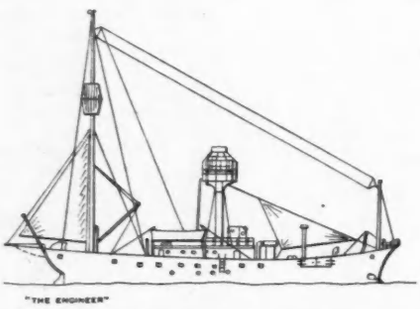


FIG. 9—LIGHTVESSEL—IRISH LIGHTS SERVICE

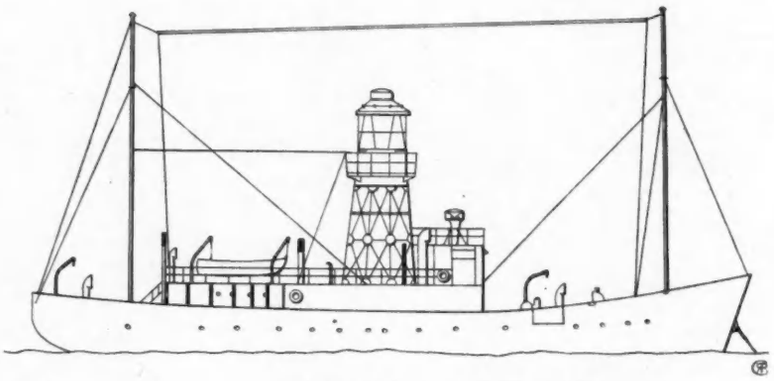


FIG. 10—TRINITY HOUSE LIGHTVESSEL

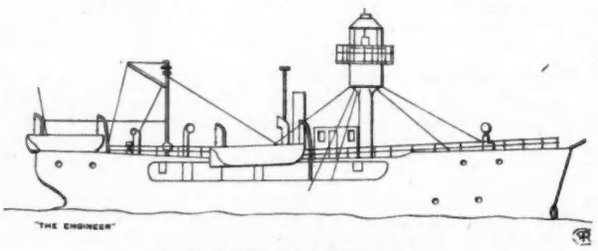


FIG. 11—SWEDISH LIGHTVESSEL

Large lightvessels of the latest type are provided with lanterns of some 8ft in diameter constructed in much the same manner—with gun-metal astragal bars—as for a lighthouse. The lantern framing is usually helical or inclined according to the strength demanded by conditions at the light station. The gutter is of cast iron, the roof of galvanised steel and the ventilator is constructed in copper.

Optical Apparatus

We now turn our attention to the optical apparatus, which constitutes the most specialised part of the lightvessel's equipment. It will be appreciated that if the optical apparatus were maintained in the same plane as the supporting structure, the emitted light would be lost in the sky one moment and be plunged into the depths the next according to the movement of the ship. In sheltered regions the rolling is catered for by providing a slight "fan" to the beam in the vertical plane. This is achieved by arranging for special vertical divergence, which implies the use of a "tall" lightsource, such as a collodion mantle. The lens in such cases is rotated by clockwork and is supported upon a mercury float or ball-bearing type pedestal with a specially designed column on a broad base. Where the movement of the vessel is considerable special means have had to be employed for maintaining the emitted beams parallel to the surface of the sea. This has been achieved by the introduction of special pendular devices which have been in operation for a number of years and which were in use, in an elementary form, in lightvessels of earlier periods. In one type of equipment a pendulum is arranged within the lantern, and upon it the optical apparatus is supported. The action of this pendulum is controlled by a further pendulum placed at the centre of gravity of the vessel. By this means the problem of local oscillation of the pendulum within the lantern is largely overcome. The apparatus used most widely in the British lightservices comprises a pendular bow and weight box mounted upon a universal pivot within the lantern (see Fig. 12). The bow is arranged to house a small electric motor and reduction gear, which is coupled to a vertical driving shaft whereby the optic is rotated, the latter being mounted upon a table and ball bearing fixed to the upper portion of the bow. Electric current is transmitted to the motor through a flexible cable. It will be appreciated that, in view of the fact that the centres of gravity of the pendulum and vessel are not coincident, oscillation of the pendulum is prone to develop. This is not regarded as serious, however, since the restricted amount of beam divergence is sufficient to cater for this oscillation in most cases. The pendular apparatus just described is of Trinity House design throughout.

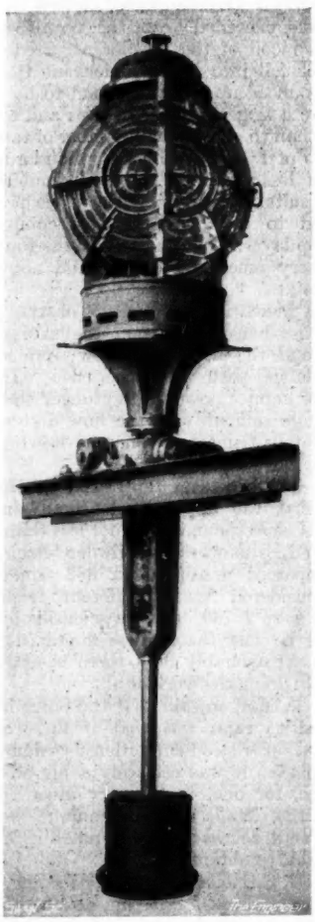


Fig. 12—Pendular Apparatus for Lightvessels

In view of the restricted period of service without withdrawal, the lightvessel has often to be constructed in such a manner as to allow it to be placed on any one of a number of light stations. For instance, at light station "A" the apparatus may be required to give a triple-flashing characteristic. After a year or two the vessel may be withdrawn for repairs and replaced on light station "B" where a red-white flashing characteristic is required. Thus the optical apparatus aboard a lightvessel has often to be constructed in such a manner as to give a number of characteristics. This adaptability has been achieved by very ingenious designs introduced by the Engineers' Department of Trinity House in co-operation with Messrs. Chance Brothers, of Birmingham. The first and most ingenious of these is known as the multi-phase catadioptric apparatus. In this a number of panels of "revolving" lens elements are made to be interchangeable in such a manner as to enable single, double, triple, quadruple or alternate flashing (white and colour) characteristics to be achieved. Furthermore, the panels are so arranged as to yield comparative intensities of white and coloured light. A single lightsource is employed with this type of apparatus and changes in speeds of revolution of the optic are obtained by adjustment of the reduction gearing on the pendular support.

It will be visualised that, with pendular apparatus in particular, optics have to be balanced very carefully. This balancing is, in some cases, carried out by floating the optic on mercury and adding weights experimentally, the final weights being attached to the optic carriage. Multi-phase apparatus requires additional experimenting with each assembly of panels together with the provision of a set of weights for each panel assembly.

Multi-phase catoptric apparatus is another type of wide application. In this type of apparatus there are four pairs of parabolic reflectors set in biform arrangement (two tiers), which may be arranged to form single or group-flashing optics at will. Each reflector or mirror subtends a separate lightsource (usually electric), and whilst the apparatus is not efficient from an optical point of view, it is comparatively inexpensive to produce and is found to be generally serviceable aboard lightvessels.

Apparatus to produce single or double-flashing characteristics have been constructed in yet another arrangement of parabolic reflectors: three mirrors or sets of two mirrors, each set subtending 60 deg. horizontally, being equispaced, are arranged in biform. The parallel beams emitted by each set of mirrors passes between the space separating the other two sets of mirrors. Upon revolution, the apparatus repeats its flashing characteristics three times per revolution. Biform apparatus of this type has also been constructed on a grand scale, the apparatus being of hyper-radial calibre, some 9ft in diameter on the focal plane; this constitutes the largest catoptric apparatus ever constructed for a lighthouse (see Fig. 13).

Where petroleum vapour is employed as the illuminant, it is customary to attach the pressure oil container at the extremity of the pendulum. The optical apparatus is usually rotated in such cases by a standard weight-driven clock, the weights being suspended in a weight tube situated within the light tower. It is thought unnecessary to provide lamp-changers and oil wick lamps are usually substituted in conditions of extreme emergency.

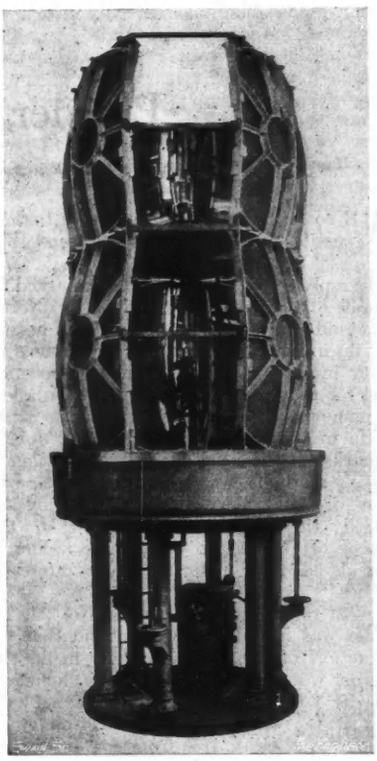


Fig. 13—Biform Hyper-Radial Catoptric Apparatus

Modern lightvessels are further equipped with powerful sound emitters for fog signalling, submarine oscillators or bells and radio beacons. These appliances are dealt with in subsequent articles in this series and it suffices to state, at this stage, that compressed air and electric current is generated on board. There are also many novel systems in operation, but these are mainly applied to unattended lightvessels. A description of these and of a typical lightvessel installation will appear in the final article in this series.

The provision of masts is often made necessary for supporting radio aerials and day-

marks. The latter are identification marks, which may be in the form of cones, spheres, globes, &c.

It is general throughout the world for the name of the light station to appear in large white letters on the sides of the hull. There is a distinction, however, in the colour of the vessels. English vessels are painted red, Irish Lights Commissioners employ black as the standard, and brown-painted vessels and white painted vessels are to be seen elsewhere.

The methods of anchorage are similar throughout the world, although the types of anchor and the materials and methods of manufacture vary. Where lightvessels are anchored to a sandy bed the "mushroom" anchor is generally in use. This anchor resembles an opened umbrella and has the action of sinking into the sand and of offering a very great resistance to being withdrawn. The grapnel type of anchor is greatly used, however, and cases of lightvessels dragging anchor are comparatively infrequent. Large anchors weigh as much as 2 tons and it is usual to employ chains of 1¾in section. These chains have been manufactured in wrought iron in the past, but are giving place to chains cast in steel, whilst handwelded chains of wrought iron are in common use.

Many lightvessels have given place, in recent years, to buoys and large automatically operating boat beacons. There are obvious advantages in such a procedure, although so long as a major light station is located in the open sea the need for the lightvessel, whether attended or unattended, will ever be present.

(To be continued)

Powder Metallurgy

No. II—*(Continued from page 53, July 18th)*

WE continue below our report of the discussion held on Wednesday, June 18th.

In reply to Dr. Chaston, who had asked for details of the hæmatite powders, Dr. Northcott said that as the work had been carried out during the war, there had been some difficulty in getting hold of hæmatite powders, and for that reason what was known about them now had not been included in the paper.

He was very pleased to hear Dr. Jones's remarks on the need for standardisation of testing methods, which supported their own plea for standardisation, to which they had added the recommendation "that this aspect of the testing of metal powders be considered and undertaken by interested bodies."

With regard to iron powder No. 25, Dr. Jones was mistaken when he said that the reduction of the oxide content made this powder worse. The main features about iron powder No. 25 were the small median size, 6μ, and the fact that the surface must obviously be pure and clean, free from contamination. These two points linked together would probably give the answer. Thus, after pressing and sintering, a normal powder (No. 9, Table XV), as received, gave a tensile strength of 10·31 tons per square inch. That was split up into seven fractions, ranging from a median size of 65μ to a median size of 5μ, and the tensile strength of the compacts then ranged from 7·9 tons per square inch to 17·7 tons per square inch. There was obviously a very considerable jump in the mechanical properties when the size was below about 12μ, provided always that the surface of the powder was clean, so that satisfactory cohesion between the particles was obtained. The peculiarity of iron powder No. 25 was that the oxide content of something over 1 per cent was the same after an attempt had been made to reduce it in hydrogen; and the point there was that this fine 6μ powder consisted of small particles, clean on the outside, with a core of oxide. It was an oxide-reduced powder, but in simple hydrogen reduction the internal oxide was not readily reduced.

Mr. R. Titterington (Murex, Ltd., Rainham, Essex), replying on behalf of Dr. Miller, who was in the United States, said that the absence of detail about the methods of producing metal powders was due to the limited space available. There was a considerable amount of additional information which could have been published if the circumstances had been different.

The question of microphotography in connection with metal powders had been raised by Dr. Chaston, and the different effects shown by transmitted and by oblique illumination in some of Dr. Miller's photographs bore out the remarks made by Dr. Chaston with regard to the necessity for further investigation into this problem.

Dr. Northcott raised a point about iron powder having good flow properties in the low μ range. That remark, he thought, was slightly out of context, because the heading under which it appeared was "Reduction of Metallic Salts." A considerable amount of work had been done on the production of very pure iron powders by the reduction of ferrous chloride by hydrogen. The material so produced was a very light sponge, and the particle size was very fine, but although the powder had a very fine grain size, it tended to form small aggregates, still in a spongy condition, and they flowed readily. He thought that the passage, as phrased, missed that point. There was one question he wished to add. Dr. Gardam stated in his paper that his routine determination of the total iron content gave an accuracy of $\pm 0{\cdot}05$ per cent. That seemed a very high standard of accuracy for routine determination in the case of a metal like iron, and he would like to know how it was obtained.

Mr. V. Morgan (Boundbrook Bearings of Great Britain, Ltd., Birmingham), referring to Dr. Northcott's paper, said he wished to comment on the method of showing his experimental results. A comparison was made in Table I between the apparent densities produced by different radii of flow meters, the figures given being 2·766 and 2·745 grammes per cubic centimetre. A difference of 0·02 grammes per cubic centimetre was roughly a 1 per cent difference. In his laboratory operators were measuring density and flow regularly day after day, and so many variables came into the measurement of density that those two results alone were a very good check. He would say that anyone quoting density figures nearer than 0·02 was rather splitting hairs, and asked to what extent the figures given were reproducible.

The method which Dr. Northcott used for determining the density was to pour the powder bit by bit into the flow apparatus and to let it fall into the cup a little at a time. Experiments which he had done had shown that very poor reproducibility was obtained by that method, and that it was far better to work with a continuous stream rather than by adding the powder a little bit at a time and letting it fall through the orifice in that way.

With regard to the tap density measurements, it seemed that Dr. Northcott allowed his sample of powder to fall 1·5in. Some experiments carried out by his laboratory in order to determine the number of taps, the intervals of the tapping and also the severity of the tapping, showed that if 1in was exceeded with the powder under test a recoil of the powder occurred. The powder fell into the cylinder, hit the base and bounced up. It was found to be better to give a larger number of taps and a short drop than to give a small number of taps and a drop of 1·5in. When they standardised a fall of less than ½in the reproducibility of the results was better. The whole problem seemed to be concerned with compacting the top layer. With a low fall the top layer was very much smaller and did not affect the result.

The indications of Fig. 5 of the paper that the longer the stem the shorter the time and the better the flow were not in accordance with his experience. In the case of copper powders the longer the stem the more difficult was the flow and with a completely truncated cone the flowing properties were better.

Dr. Northcott, in reply to Mr. Morgan, said that the apparent density values in Table I were the means of not less than three tests. In the works, a powder which gave an apparent density of 2·382 would not be considered vastly different from one which gave 2·766, but in a scientific investigation he felt that unless standards were at least reasonably high there is not much point in doing the work at all.

Mr. V. Morgan said that the point he had wanted to raise was that if there was a method of reproducing density figures to four places, it was certainly a big advance, and he, for one, would very much like to know the details of the technique, because 1 per cent accuracy was as much as he had been able to obtain.

Mr. E. C. Rollason (Murex Welding, Ltd., Rainham, Essex), referring to methods of measuring particle size and surface area, said that Dr. Northcott and his colleagues had selected one developed by Lea and Nurse, which depended upon air permeability. For another purpose the company with which he was associated developed a very quick method of measuring surface area, using the "Spekker" absorptiometer. The powder was suspended in a suitable deflocculating liquid, such as ethylene glycol The method had been published in the *Journal* of the Society of Chemical Industry, March, 1945. It had been found to be extremely useful for controlling the particle size of various minerals and metal powders; the metal powders, incidentally, had not been used for powder metallurgy. He would like to ask whether this method had been considered and whether the authors could comment on its use.

The chairman, in closing the discussion on Sections A and B, said that he was very interested in Dr. Chubb's contribution with regard to chemical methods of making powders, but was not quite clear whether he had said he had published his results as he believed that work on very similar lines was

being done in different parts of Europe. He hoped that Dr. Chubb would submit a historical note of his earlier work in writing later.

Magnetic Powders and Products

The chairman then asked Dr. Pfeil to introduce the following papers :—

Section C.—"Magnetic Powders and Products": (6) "The Nature, Properties and Applications of Carbonyl-Iron Powders," by L. B. Pfeil; (7) "Comparison of Magnetic Powder Cores for High and Low Frequencies," by G. R. Polgreen; (8) "Nickel-Iron Alloys for the Production of Dust Cores," by S. E. Buckley; (9) "High Magnetic-Permeability Powder-Iron Components," by D. A. Oliver; (10) "The Production of Sintered Permanent Magnets," by S. J. Garvin.

Dr. L. B. Pfeil (Mond Nickel Company, Ltd., Birmingham) said that it was notable that a variety of problems could be appropriately discussed in this section. There were papers by Mr. Polgreen and Mr. Buckley, concerned with highly specialised problems of magnetic dust cores; by Mr. Garvin and Mr. Oliver, which dealt respectively with sintered magnets and with pole pieces; and a fifth paper dealing with the production and properties of a carbonyl-iron powder. This might perhaps have been included in Section B of the symposium, which was concerned with the preparation, properties and testing of metal powders, but the special characteristics of the carbonyl-iron powder make it particularly suitable for certain magnetic applications, and the paper therefore fell conveniently into Section C.

There were a number of common factors in the papers in Section C which he might first summarise. A characteristic of great importance in magnetic products was permeability. The permeabilities of most ferromagnetic materials were several hundred or several thousand times the permeability of air or space, and from this it was clear that the permeability of a compressed powder would be largely influenced by the admixture of even a small proportion of voids or of non-magnetic material.

The relationship between the effective permeability of a compact and the intrinsic permeability of the magnetic material was illustrated by Mr. Buckley in his paper, under the heading "Constancy of Permeability of Dust Cores." His figures indicated that, in the case of such cores, where the effective permeability lay in the range of 10 to 150, the intrinsic permeability of the alloy had little effect on the permeability of the core, owing to the important part played by the insulation between the particles. It thus appeared that particle size and shape, the behaviour of the powder under pressure and the thickness of the insulating film between the particles were of more importance than the intrinsic permeability of the alloy.

In the case of high permeability pole pieces, produced from pressed and sintered iron powder, Mr. Oliver showed that the permeability of the sintered material, although never quite as high, reached the same order as that of solid materials of the same general type. Here, although the effect of the particle junctions was still probably playing a considerable part, the fundamental properties of the iron were becoming the more important factor. Possibly that was the reason why the densities of the compact do not correlate more exactly with the permeability. It would be of interest to know whether it was possible to separate the two variables, magnetic dilution due to the voids and inclusions and magnetic permeability variations due to the chemical impurities and to structure, thermal treatment, &c., with a good supply of such information it might be possible to form a general theory and to link up these cases with an explanation of the permeabilities of dust cores, the discrepancies and difficulties of which were mentioned by Mr. Buckley.

Mr. Garvin mentioned in his paper that the remanence of sintered iron-nickel-aluminium magnets might be 10 per cent lower than that of the regular alloy, and suggested that that might be due to porosity. Although, as in the case of sintered pole pieces, the magnetic properties were probably somewhat modified by the various thermal and mechanical treatments which differed from those used in producing the cast material, it certainly seemed likely that the question of magnetic dilution with voids was playing an important part in this matter.

A property of special importance in magnetic applications was high purity; that referred not only to the absence of small amounts of mechanically admixed impurities, but also to elements likely to affect the magnetic properties adversely, such as sulphur, phosphorus and oxygen. The first type of impurity affected the magnetic dilution, and the latter, besides affecting the intrinsic permeability, might also increase the hysteresis losses.

Turning to a few special points in the two papers that deal essentially with dust cores, Dr. Pfeil said that both Mr. Polgreen and Mr. Buckley discussed the significance of the three causes of core losses in terms of the hysteresis loss coefficient, the eddy current loss coefficient and the mysterious loss which was called the viscosity or residual loss. It was pointed out that the relative importance of these losses varied with the frequency and that different types of powder—iron, nickel-iron, nickel-iron-molybdenum and others—possessed varying characteristics. Accordingly, great skill and experience were required to choose the correct product for each type of application.

In a number of important applications higher permeability would be of very great value if it could be obtained without increased losses. It was perhaps not altogether clear from those papers whether the search should be directed towards powders having a higher intrinsic permeability or towards a reduction in the amount of magnetic diluent which was used for insulation purposes between the particles. Metallurgists who were concerned with the production of magnetic powder needed guidance here from physicists, because if a higher intrinsic permeability was particularly desired in metal powder for dust cores it might be necessary to accept increased losses. Again, the metallurgist might well be asking himself whether it would be of value if he could produce an iron powder of high purity and good physical form, so that it packed well and had a coarsened particle size, or whether he should direct his attention to a nickel-iron alloy powder with good packing characteristics and a finer particle size than had so far been available. In the first case he might argue, in his possible ignorance of these physical matters, that higher permeability dust cores could be produced without the complications involved in a final heat treatment, and in the second case he might argue that such a powder should give him cores with reduced eddy-current losses, which would be suitable for very high frequency, the losses being reduced by virtue of the relatively high electrical resistance of the nickel-iron alloys.

Dr. Pfeil then drew attention to a few matters which are particularly relevant to Mr. Oliver's paper on sintered iron pole-pieces and to Mr. Garvin's paper on sintered iron-nickel-aluminium magnets. Mr. Oliver referred to the advantages of sintered iron pole-pieces, more particularly in the saving in machining costs, to the difficulties involved in obtaining magnetic properties fully equal to those obtainable in standard materials, and to the need to eliminate voids and the effects of particle distortion. Experiments had been carried out by Mr. Oliver on a 4 per cent silicon-iron powder, which should have the advantage of a higher electrical resistivity, thus reducing the eddy-current losses when an alternating magnetic flux is involved. He (Dr. Pfeil) would have supposed that the use of silicon-iron powder would increase to some degree the sintering difficulties associated with the use of elements which have a high affinity for oxygen, that being a matter to which Mr. Garvin had drawn attention. Mr. Garvin, in his paper, showed how pre-alloying might be used to avoid the formation of a liquid phase during sintering, and, in the case of aluminium and cobalt, might have a useful effect in reducing the tendency for films of alumina to form on the particles. Appropriate choice of particle size and shape and of moulding conditions should serve to reduce the difficulties inherent in the handling of highly reactive elements, in powder metallurgy and a method was described for preventing the formation of oxide films by surrounding the articles during sintering by material having a still higher affinity for oxygen than the affinity of the constituents of the compact.

The growing importance of alloys containing substantial amounts of highly reactive elements, such as niobium and titanium, indicated that much further work was desirable on sintering operations under completely non-oxidising conditions.

Finally, Dr. Pfeil said a few words to introduce paper No. 6. Carbonyl-iron powder was used for dust cores because of the unique shape of the particles, the structure of the particles and the magnetic properties that they possess. There were two common varieties of carbonyl-iron powder, the high carbon hard grade, which was available in this country under the description "ME grade," and was used for high-frequency cores, where eddy-current and hysteresis losses must be at a minimum and the decarburised soft grade, which was used where higher permeability is essential.

Certain applications for carbonyl-iron powder other than dust cores were briefly mentioned in the paper. Those uses depended mostly on the high purity of the decarburised powder and to some extent on the particle size and particle shape.

(To be continued)

Marconi Jubilee, 1897–1947.—The Marconi Company has published a handsome commemorative brochure to mark the fiftieth anniversary of the establishment of the company and to indicate its contribution to every branch of radio. In its fifty-seven pages of letterpress and illustrations, this book succeeds in recapturing some of the spirit of enthusiasm and determination that animated Marconi and his collaborators in the early historic experiments and in the subsequent development of radio communication. Illustrations such as those showing Marconi's first transmitter and the transmitting apparatus used for the first transatlantic experiments at Poldhu, in December, 1901, will be of interest to a generation that has seen a laboratory toy grow into an integral part of modern life. An interesting link between the past and present is contained in a photo-engraving showing reflectors of the type used as transmitter and receiver by Marconi in his early directional experiments; it is instructive as well as sobering to compare this apparatus with its modern counterpart as used in centimetric work.

The Public Works, Roads and Transport Congress and Exhibition

No. I

THE Public Works, Roads and Transport Congress and Exhibition was opened at Olympia in London by the Prime Minister, Mr. C. R. Attlee, on Monday, July 21st. During the week of the exhibition, which closes on Saturday, July 26th, eleven professional institutions are holding conferences and some twenty-two papers are being read and discussed. Nine of the papers deal with various aspects of roads and bridges, two with sewage, and two with gas; other papers deal with the training of municipal engineers, coast erosion, centralisation of municipal transport, transport of refuse, &c.

More than 140 firms are represented at the exhibition and the following article describes some of their exhibits.

Candy Filter Company, Ltd.

A representative selection of the wide range of water purification plant made by the Candy Filter Company, Ltd., of Church Road, Hanwell, London, W.7, is displayed on the stand taken by that company.

A section of filter floor as used in the firm's rapid gravity filters clearly shows the constructional details and the system for the positively uniform distribution of compressed air and water adopted for filter washing.

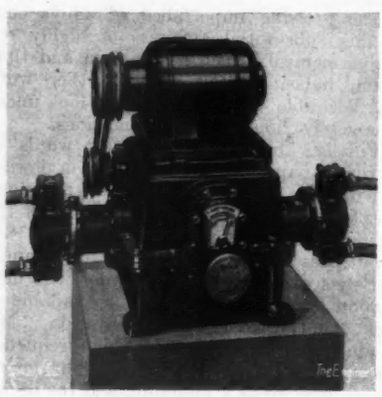


Fig. 1—Variable Stroke Chemical Injection Pump—Candy

In order to ensure continuity of chlorination and reduce the time required in supervision and checking of cylinders this company has developed an automatic cylinder changing chlorinator. With this system, known as the "Clorexchange," an empty cylinder can be replaced at any time and can become a routine operation to be carried out at any predetermined time. In the apparatus two primary pressure-reducing valves are used in parallel, one being set to discharge the gas at a pressure of 25 lb per square inch and the other at 20 lb per square inch. Each valve is connected through a gas filter to its own chlorine cylinder.

The outlets of the two valves are also interconnected so that, as long as the operating cylinder is discharging gas at a pressure of 25 lb per square inch or over, the valve set at 20 lb per square inch remains closed. When the cylinder pressure falls below 25 lb the lower pressure valve opens and brings the second cylinder into operation. Both cylinders discharge together until the pressure in the late working cylinder is reduced to 20 lb per square inch, by which time the full supply is taken from the reserve cylinder which has just come into use.

A pressure-operated indicator shows clearly which cylinder is discharging and the empty cylinder is replaced at a convenient opportunity after the indicator denotes that the reserve cylinder is in use.

To enable the cycle to be repeated and to ensure that there is always a full reserve, it is necessary to use the cylinders in the order in which they are fitted, *i.e.*, the new cylinder must always become the reserve. This is arranged by means of a pressure-transposing lever, which is moved over after the new cylinder is fitted, to reverse the pressure of the reducing valves, and so to retain the late reserve cylinder in the working position.

This firm's standard range of "Minor" variable-stroke, chemical-injection pumps now includes a series of units for working pressures of up to 3000 lb per square inch, and for capacities up to 300 gallons per hour. They are designed for use where a chemical solution has to be injected into a main under pressure at any given constant rate. One of these pumps, of the duplex type, is illustrated in Fig. 1. The main component is the "Varistroke" gearbox, which totally encloses all the working parts in an oil bath. It gives an infinitely variable stroke from zero to maximum, and can be adjusted whilst the pump is running.

The mechanism consists essentially of an eccentric the throw of which is adjustable by means of a sliding block. The eccentric is not attached directly to the shaft, but rides on a steel cylinder which is a sliding fit on the shaft. This cylinder, which is driven by the motor through the reduction gear, has its axis at an angle to the centre line of the shaft so that, when it is moved axially, the eccentric is caused to move radially and thus to change its degree of throw. The whole unit rotates as one piece inside a slide block which runs between guides attached to the pump rods, and so imparts the reciprocating motion to them. A stroke-indicating pointer is operated by a simple mechanism to show the position of the cylinder and hence the length of stroke.

Under-Water Cutters, Ltd.

The two firms of Under-Water Cutters, Ltd., and Under-Water Welders and Repairers, Ltd., of 26-27, St. James's Street, London, S.W.1, specialise in metal cutting and arc welding under water. On their stand is erected a water tank, fitted with glass windows, in which under-water welding, cutting and bolt-driving operations are being carried out by a diver, who also uses various other equipment as would be done under practical conditions.

An under-water lighting unit which has been developed is made in two standard types, with either a control box, enabling the lamp to be used with a.c. or d.c. mains current, or an engine-driven generating unit which supplies the required current.

The light source is a high-pressure mercury vapour contact source lamp consisting of a quartz bulb containing two tungsten electrodes between which an arc of high brightness burns steadily, consuming 250W at approximately 67·5V at the lamp terminals. The glass bulb is mounted in a metal box having heat-resisting glass windows through which the light emerges. This type of lamp is particularly suitable for under-water lighting, as it gives a small concentrated source of high brightness operating over a long life with little deterioration in light output.

The optical system consists of two 4in diameter plano-convex lenses, designed and mounted in such manner that the light source is condensed into an intense beam approximately 4in diameter. These lenses are made of heat-resisting glass and are not damaged by the heat of the lamp.

The lenses are carried in a special mounting fitted to the inside of the front plate of the lighting unit casing.

The lamp casing is constructed of bronze, being cylindrical in shape with front and rear plates. The condenser system is fitted to the fixed front plate behind a small window through which the light emerges. The detachable rear plate is fixed by means of bolts and to it are fitted all the electrical connections, together with the lamp bracket and plug.

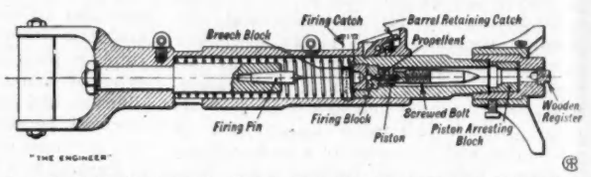


Fig. 2—Cox Submarine Bolt Driving Gun—Under-Water

It is stated that this lamp has been put through extensive tests at depths varying up to 150ft, and in thick black muddy water where hitherto visibility was nil, with the aid of this type of lighting a visibility of from 12in to 24in can be obtained.

Upon this stand there may also be seen the Cox submarine bolt-driving and punching gun. This is an explosively actuated gun which is designed to drive solid or hollow screwed bolts and punch holes in steel plate up to 1in thick above or below water, without recoil, flash or report. It can be used for a variety of purposes, including the rapid attachment of steel plate patches, splinter boxes, &c., the construction of coffer dams and the attachment of eye plates and other fixtures for lifting and salvage purposes.

The construction of the gun is shown in the drawing reproduced in Fig. 2. The gun has a detachable barrel which is loaded with ammunition above water and sealed. A supply of the loaded sealed barrels may be carried by the diver or loaded barrels can be lowered to him as required. The barrels can quickly and easily be fitted and detached from the gun.

For these guns the bolt ammunition has a bolt $\frac{5}{8}$in diameter, $4\frac{1}{2}$in long, threaded B.S.F., and is available loaded to suit steel plate from $\frac{1}{4}$in to 1in thick inclusive. The bolt is of 100-ton tensile heat-treated alloy steel, and has a shearing strength of 10 tons. A pressure of 12 tons has been found necessary to force a bolt out of $\frac{3}{4}$in plate.

Bolt ammunition is supplied in a box which contains a suitable supply of sealing washers, wooden locating registers, and nuts to suit the bolt.

In the punch ammunition the punch is $\frac{11}{16}$in diameter and produces a hole of a size to suit the bolt. It is available loaded to suit steel plate from $\frac{1}{4}$in to $\frac{3}{4}$in thick inclusive.

For special requirements punch ammunition can be produced to punch holes of any diameter within the capability of the apparatus.

THOS. FIRTH AND JOHN BROWN, LTD.

In addition to a range of typical steel castings for pumps, stone breakers, crushers, excavating machinery, &c., a selection of engineers' cutting tools is to be seen upon the stand of Thos. Firth and John Brown, Ltd., of Sheffield. Amongst these tools is a portable electric plane made by G. and W. Lowe, Ltd., which has been developed to meet the need for increased producton and partly fill the demand for portable power-driven tools in the woodworking industry.

The plane is produced as a standard tool suitable for flat planing. It is powered by a ½ h.p. Universal a.c./d.c. motor running at 15,000 r.p.m. and directly connected, through worm and worm wheel, to the cross shaft of a small gearbox which forms an integral part of the motor unit. The reduction ratio to the driving spindle is 3½–1, giving the cutter spindle a speed of approximately 4500 r.p.m. Drive from the cross shaft to the cutter spindle is by roller chain and sprockets adequately protected by a chain guard. For safety of control there are two switches, one in the main handle and one conveniently mounted in the forward hand rest; until both switches are closed the cutter will not revolve.

Depth of cut is controlled by a single regulating nut graduated in thousandths of an inch and fitted with a "clicker" spring. The cutter spindle carries a 3in diameter by 2in face multi-blade cutter and is mounted on two self-aligning ball races, totally enclosed in their respective housings. Each ball race housing has an eccentric adjustment of 1/64in to provide axial adjustment, which may be necessary after resharpening the cutter.

RAPID CONCRETE BREAKING COMPANY, LTD.

For its sub-contracting work as concrete breakers the Rapid Concrete Breaking Company, Ltd., of 93, Lancaster Gate, London, W.2, employs a fleet of heavy-duty machines brought to this country from the United States. Three types of these concrete-breaking machines are made, and one of the largest, illustrated in Fig. 3, is to be seen upon the firm's stand. This machine, which is designed to break concrete up to 2ft thick gives controlled blows of up to 20,000ft-lb at a rate of from 50 to 60 per minute. It is pneumatically operated and, as it gives the concrete a controlled shearing blow, there are no ill-effects from vibration.

As can be seen from the illustration, the concrete-breaking unit is mounted on a turntable on the chassis of a lorry. An independent engine-driven compressor set supplies air at 310 lb per square inch to the concrete breaker, which is set on a rearward overhanging extension of the turntable. The breaker itself comprises a vertical cylinder of 7in bore, the piston-rod of which is extended downwards and carries an interchangeable hammer head. The piston stroke is 42in of which 32in is used for the actual working stroke. An operator sitting behind the breaker has a clear view of the hammer and directly it strikes the concrete reverses the air flow to raise the piston for the next stroke. Between strokes the operator traverses the hammer in short steps over 180 deg. of an 82in working radius. Traversing is effected by movement of the control lever of a small air-operated motor which rotates the turntable. At the completion of each working traverse the lorry is driven forwards a predetermined distance and breaking proceeds in the reverse direction over the working arc.

In order to avoid possible damage by traversing the breaker when the hammer is in contact with the broken surface below, the unit is mounted on a horizontal trunnion and held in position by a heavy leaf spring which permits a restricted tilting movement of the assembly.

J. BROCKHOUSE & CO., LTD.

The "Lewin" refuse collector made by J. Brockhouse and Co., Ltd., of West Bromwich, is designed to give dustless loading and discharge and at the same time incorporates means of compressing the load to use the maximum storage capacity of the body.

This collector has a mild steel cylindrical container mounted on rollers fixed to the chassis frame. The forward end of the container is closed and carries a chain sprocket and shaft driven through a power take-off from the engine. The shaft is enclosed and extends to the rear of the container where it is keyed to a twin half-helix impeller adjacent to the loading chute, to be seen in Fig. 5. A non-rotating hinged cover and charging plate is fitted at the rear of the container, and is raised hydraulically by hand from a pump behind the driving cab. The impeller is driven whilst refuse is being tipped into the loading chute, and moves the waste forwards into the body of the container. Rotation of the impeller keeps the chute clear and at the some time tightly packs the refuse.

The container itself remains stationary during loading. When it is required to discharge its contents the hinged cover at the rear is swung clear and the impeller rotation reversed. At the same time the body is rotated, a scroll within the container assisting in ejecting the refuse. No tipping gear is used and the container rests horizontally on the chassis at all times.

As can be seen from the illustration of the vehicle in Fig. 4, the top of the casing forms a large carrier for salvage or bulky articles.

H. R. MARSDEN, LTD.

A range of stone-breaking machinery to be seen upon the stand of H. R. Marsden, Ltd., Sweet Street, Leeds, includes one of the firm's "Rotosnap" swing hammer impact granulators for the reduction of rocks and minerals. These machines are made in five sizes to produce from 5 to 60 tons of uniform cubical chippings per hour.

As can be seen from the photograph we reproduce in Fig. 6, the machine comprises three main sections. Mounted on roller bearings in the heavy cast iron base is a cast steel rotor fitted with swing hammers. The

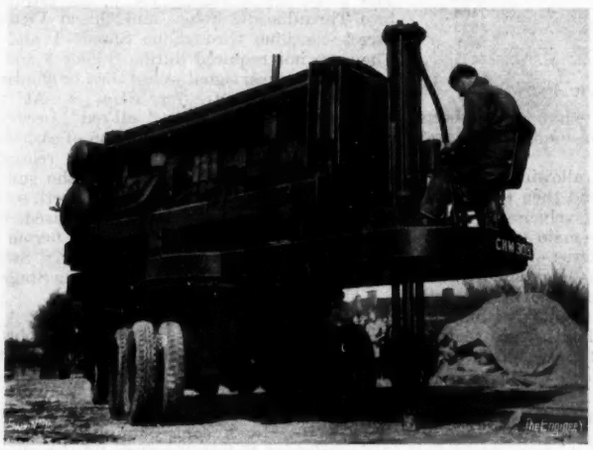


FIG. 3.—CONCRETE BREAKER—RAPID CONCRETE

FIG. 4—REFUSE COLLECTOR—BROCKHOUSE

FIG. 5—REAR OF REFUSE COLLECTOR CONTAINER—BROCKHOUSE

sides of the two upper sections are of heavy gauge mild steel plate and are held rigidly together in box form by means of flanged steel end plates and bolts. The inner sides of the base and upper sections are protected against wear by sectional chilled iron plates of a convenient size and weight for handling.

The peripheral anvil wall connecting the two side plates consists of a series of sectional cylinders made of a special alloy having high abrasion-resisting properties combined with

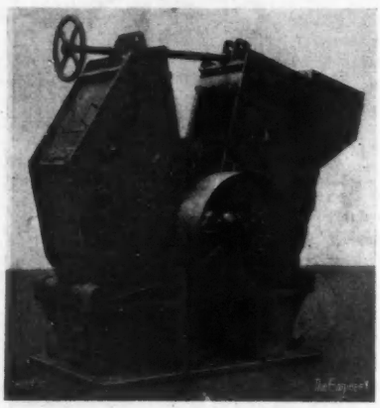


FIG. 6—SWING HAMMER GRANULATOR—MARSDEN

structural strength. These cylinders are closely disposed to one another and are supported in circular apertures in the side plates as well as on a polygonal steel mandrel. In order to present a new wearing surface on the anvil wall the mandrels are loosened and turned to rotate the cylinders.

The two upper sections of the machine are hinged on the base and can be swung apart by means of a screw and a handwheel so that the interior can be inspected or the hammers and side plates renewed.

SOME REFUSE COLLECTION AND OTHER VEHICLES

The Ford Motor Company, Ltd., of Dagenham, is exhibiting two side-loading refuse collectors, one of 7 and the other of 12 cubic yard capacity; a 500-gallon combined gully and cesspool emptier, and a 25ft three-stage tower wagon. Each of these is mounted on one of the firm's "Thames" chassis fitted with a 30 h.p. V.8 engine.

Karrier Motors Ltd., of Luton, is demonstrating no less than six types of municipal vehicles, four of which are designed for refuse collection, one of 750-gallon capacity for cesspool emptying, and one of similar capacity for gully emptying. A 15 cubic yard capacity mechanical loading collector made by this firm is designed to lift fully loaded refuse bins, discharge their contents into the body of the vehicle, then lower and detach the bins, all movements being fully automatic. The speed of the hydraulically operated bin mechanism can be varied from dead slow to a full lift in three seconds, whilst the return and release movement takes from four to five seconds.

In addition to equipment to be seen on some of the vehicles on the stands of the Ford Motor Company, Ltd., and Vauxhall Motors Ltd., the Eagle Engineering Company, Ltd., Warwick, is showing on its own stand a 500-gallon cesspit emptier, refuse-collecting body of the side-loading type, a sweeping machine, and a three-stage power-operated tower wagon.

A self-loading refuse collector built by Scammell Lorries Ltd., known as the "Essloo," is made for operation in conjunction with one of the maker's three-wheeled "Mechanical Horses." Refuse is tipped over a sill at the rear of the vehicle into a hopper which, when full, automatically raises its load and tips it over a barrier into the body of the vehicle. This hopper traverses along the top of the body and, as it fills first levels the refuse and then compresses it until the storage space is completely filled.

A 3–4-ton long wheelbase "Bedford" chassis of Vauxhall Motors Ltd., Luton, is fitted with an Eagle moving floor 15 cubic yard refuse wagon body, and a 2–3-ton long wheelbase chassis has on it a side-loading, 7 cubic yard Eagle refuse-collecting body. A 5-ton chassis is to be seen with a 600-gallon capacity gully-emptying equipment.

Dennis Brothers Ltd., of Guildford, has four vehicles on exhibition, an 800-gallon gully emptier, a cesspool emptier of similar capacity, and two refuse-collecting wagons.

In addition to four refuse wagons varying in capacity from 8–9 cubic yards to 24–25 cubic yards, Shelvoke and Drewry, Ltd., of Letchworth, has built a 1100-gallon gully emptier.

(To be continued)

Traffic Signals at the "Bank Complex," City of London

THE name "Bank Complex" has been given to the area which is the junction of Threadneedle Street, Cornhill, Lombard Street, King William Street, Princes Street, Queen Victoria Street, Poultry and Mansion House Street. A specification for traffic signals to control the heavy traffic at this junction was prepared by the Ministry of Transport in collaboration with traffic officials of the City of London Police, and a control system to meet the requirements was designed by the Automatic Telephone and Electric Company, Ltd., of Strowger Works, Liverpool, using "Electro-matic" vehicle-actuated signals. This installation was officially inaugurated by the Lord Mayor of London on Wednesday of this week, July 23rd.

The signals will operate on a plan designed in the first place to ensure efficient control at the "Complex," but, in addition, other junctions in the immediate vicinity will be controlled by the same master timer, to permit free flow of traffic to and from the "Complex."

An accompanying drawing shows the positions of the traffic signals. From the drawing and the aerial view reproduced above the difficult and complex layout of the junction will be appreciated, particularly when it is realised that no less than 35,000 vehicles use the junction each twelve hours and that most of the approaches are narrow. The actual figures for the various approaches in the 1939 census were:

King William and Lombard Streets ...	5833
Princes Street	5545
Poultry	7408
Queen Victoria Street	5839
Cornhill	5048
Threadneedle Street...	5429

STAGES OF TRAFFIC FLOW

To deal with this heavy volume it has been arranged for traffic to flow in four main stages, as shown in the diagrams.

The general principle of allowing east and west-bound traffic to flow and then permitting the north and south-bound vehicles to move has been followed. The four main stages of the traffic movement are as follows:—

Stage 1.—Traffic flows through Queen Victoria Street and Threadneedle Street, but vehicles in either of these streams wishing to turn off to Cornhill or to Poultry are temporarily "held"; otherwise they would have to cross the traffic stream, which would be dangerous. Cross-traffic from Princes Street and King William Street is held for the same reason. Traffic from Poultry and Cornhill is also held until the head of the line of vehicles from Queen Victoria Street and Threadneedle Street has passed.

Stage 2.—Traffic from Poultry and Cornhill now joins in, but traffic wishing to turn into Cornhill and into Poultry is still temporarily held to avoid crossing the main stream.

Stage 3.—Traffic now flows from Poultry across to Threadneedle Street and Cornhill, and from Cornhill to Poultry and Queen Victoria Street. Outgoing traffic from Queen Victoria Street and Threadneedle Street is held to avoid crossing the main streams which are flowing. At this stage traffic is permitted to flow out from Lombard Street, but is temporarily held a little further on.

Stage 4.—North and south traffic from King William Street and Princes Street is now allowed to flow with the east and west-bound traffic held Traffic from King William Street also flows into Queen Victoria Street and Poultry, vehicles from all the other roads being stopped.

In addition to the main stages detailed above there are a number of so-called minor stages. Although usually termed the minor stages each of these is important. These minor stages are:

Minor Movements During Stage 1.—Traffic from Queen Victoria Street is given a short lead of approximately three seconds before the traffic from Threadneedle Street and Mansion House Street (eastbound) is released, so as to take advantage of an "all-red" clearance period which follows Stage 4. Green arrows are provided to permit filtration of traffic into Threadneedle Street (eastbound) and into Queen Victoria Street (westbound). If there is no demand for right-of-way from Threadneedle Street the right-of-way may be taken by Cornhill. Similarly, if there is no demand from Queen Victoria Street right-of-way may be taken by Poultry, and if this does occur neither Queen Victoria Street nor Threadneedle Street is permitted to take right-of-way during the particular cycle of signals.

Minor Movements During Stages 1 *and* 2.—The green arrow signals for traffic filtration into Threadneedle Street and Queen Victoria Street continue throughout Stages 1 and 2. They are not required during Stages 3 and 4, as the main green signal would then be showing.

Minor Movements for Stage 4—At the beginning of this stage an "all-red" period is introduced to clear the intersection of east-west traffic before north-south traffic is released. Similarly, an "all-red" period at the end of the stage permits clearance of north-south traffic before east-west traffic is released, but in this case an exception is made in favour of traffic entering from Queen Victoria Street as detailed in minor movements during Stage 1.

SIGNAL OPERATION

The whole system is "Electro-matic vehicle-actuated," operating on the "flexible-progressive" principle under the control of a dual-master-timer. Vehicle detectors are used in each approach street. The signals themselves are actuated by a control unit divided into seven sections linked together to co-ordinate the signal phases.

Right-of-way is given to an approach only if there is a demand, and the length of this right-of-way period depends, up to a predetermined maximum, on the volume of the traffic. Right-of-way is offered to each approach in a definite sequence and according to a progressive plan by means of a master timer which sends out timed pulses to maintain strictly the cycle of operations.

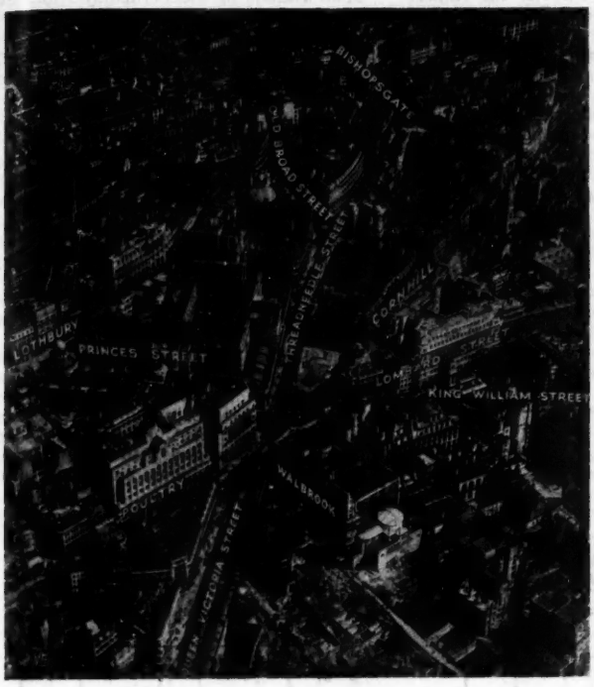
Special arrangements are made whereby in certain cases right-of-way time not used by

one approach during any cycle may be used by a second approach. The pairs of approaches having this facility are Threadneedle Street and Cornhill; Queen Victoria Street and Poultry; Lombard Street and King William Street.

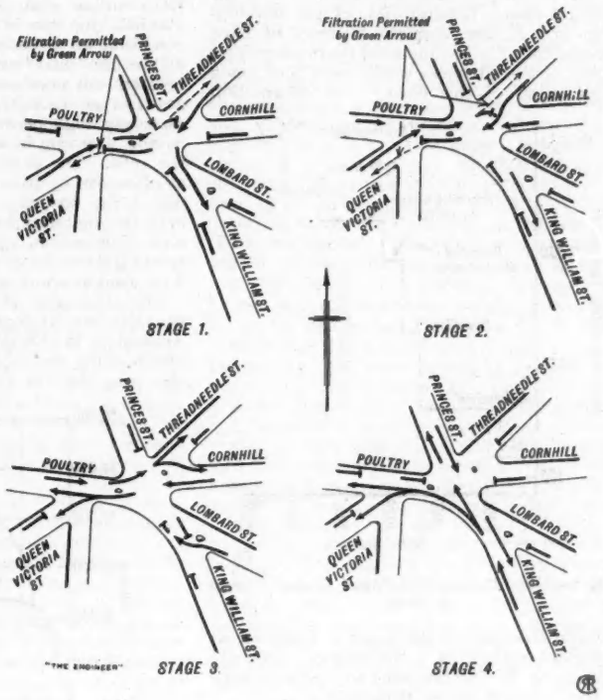
A recent "Electro-matic" signal development, known as "biassed linking," has been applied to link the "Bank Complex" with several adjacent intersections, and thus form one complete scheme. The other intersections are Threadneedle Street and Old Broad Street; Threadneedle Street and Bishopsgate; and Princes Street and Lothbury. Provision has been made for incorporating at a later date the linking of the intersections of Cornhill and Bishopsgate, and Cheapside and Queen Street. These intersections are already individually controlled by "Electro-matic" signals, and to connect them on the "biassed linking" principle all that will be required will be to change the two controllers.

Biassed Linking

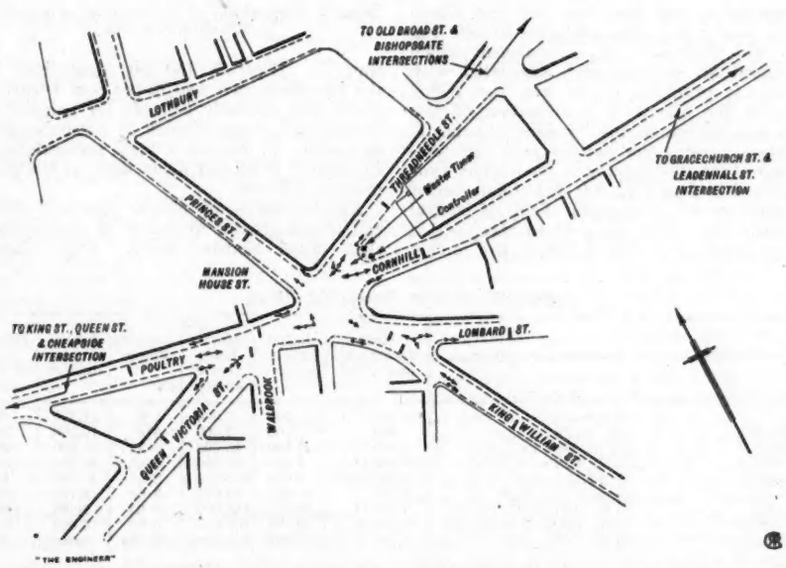
Briefly, with "biassed linking" precisely as in ordinary "Electro-matic" control, vehicles receive individual "consideration" by means of the road detector and the controlling mechanism. In addition, a special reservation is introduced into the timing which can best be described as a "right to priority" period. This special period is introduced into the timing by the master timer for the benefit of vehicles flowing along the main road or over a prearranged through traffic route; or it can be described as a period during which normal traffic control is in operation, but during which the particular through traffic has a special "priority right" to the "green" signal and can thus temporarily override the claims of cross-road vehicles which would otherwise cause delay. The priority period is introduced into the timing cycle at each intersection, and it is introduced in successive stages of the timing according to the progressive plan.



THE "BANK COMPLEX"



MAIN STAGES OF OPERATION



MAIN SIGNALS AT THE "BANK COMPLEX"

In operation, if a vehicle or block of vehicles arrives at an intersection when the signal is showing "green," no delay is encountered at the particular intersection. But in the usual co-ordinated system involving a number of intersections it may happen that traffic having crossed one intersection encounters the "red" signal at the next. With "biassed linking" the timing is so arranged that if each traffic-group is travelling at the correct speed, it will arrive at each successive intersection within the "right to priority" period and so immediately secure the "green" signal. As this special period is introduced only as one section of the complete cycle of timing there is no undue penalising of cross traffic and the highly important result is achieved of one or more blocks of main line traffic moving at a constant speed without interruption or delay at any of the intersecting roads.

British "Austerity" Locomotives Repaired in Belgium.—Belgian engine shops are working at high pressure on the repair of 165 British "Austerity" 2–8–0 locomotives urgently needed for coal transport in Britain. They are among the last of the fleet of 935 engines which were sent to the Continent for the Second Front and are being recalled for use at home to help overcome transport difficulties. Since January these locomotives have been moving into Belgium, from all parts of France, for repair. The repair facilities in Belgium, says the Ministry of Supply, means that soon the great majority of invasion locomotives will be in service on British railways. During last year, 460 of the engines, after heavy and continuous service on continental railways, were sent to Britain, where engine shops, already working to capacity, had to overhaul many of them before they could be commissioned for coal transport. For this reason, more "Austerity" locomotives operating in France were directed to Belgian workshops to overcome the acute shortage of repair facilities in Britain. Of the original D-Day "Austerity" 2–8–0 locomotives, 246 have been sold or are still needed by the Occupation Forces in Germany. The remaining 689, including those still under repair, will eventually reinforce the depleted goods transport of Britain.

Metallurgical Topics

Magnetic Alloys of High Permeability

THE announcement by O. L. Boothby and R. M. Bozorth,* in a communication from the Bell Telephone Laboratories, of the development of "A New Magnetic Material of High Permeability" is accompanied by an interesting review of the advances which have been made in materials of this class. The information

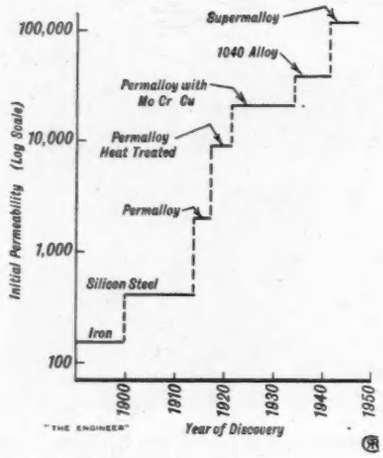


FIG. 1—*Initial Permeabilities Plotted Against Year of Discovery*

given in this part of the paper is based on an important article on "Magnetism," specially written by R. M. Bozorth† for the new issue of the "Encyclopædia Britannica."

The demand for alloys of very high permeability and low hysteresis loss arose in connection with the manufacture of transformers and in telephone and ocean cable work. By the progressive development of such alloys there has been an almost continuous increase in the speed of signalling possible with long distance submarine cables. The main steps

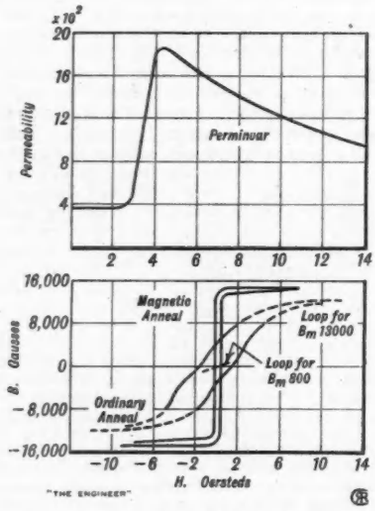


FIG. 2—*Permeability and Hysteresis Loops for Perminvar*

in the development from soft iron to the new material — "Su-perm-alloy" — are indicated graphically in the chart reproduced in Fig. 1 of initial permeability plotted against the year of discovery of the material concerned.

Although the first transformer sheets were made of soft iron of the purest quality then commercially available, it was early recognised that carbon present as an impurity exercised a bad effect on permeability and hysteresis loss, and alloys of iron and silicon containing about 4 per cent of silicon and almost free from carbon were introduced by Sir Robert Hadfield for use in the rolled and annealed condition as transformer sheet. Cold rolling before the final annealing is an advantage because the crystals composing the material are then so orientated that the sheets have an especially high permeability when magnetised in the direction in which they passed through the rolls. The elimination of oxygen as well as of carbon by treatment in hydrogen at 1200 deg. Cent. was also recognised as important, and the material known as Hipersil (3 per cent silicon-iron, cold rolled and hydrogen treated) showed a great advance on the original 4 per cent silicon-iron.

The discovery of Permalloy (nickel 78·5 per cent, iron 21·5 per cent), as a result of the work of G. W. Elmen on the iron-nickel alloys about 1920, was an important advance; as also was that of the method of treating it

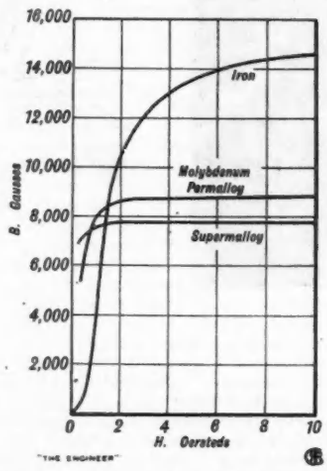


FIG. 3—*Magnetisation Curves for Supermalloy, Molybdenum-Permalloy and Iron*

by heating at not less than 900 deg. Cent., cooling slowly and then reheating to 600 deg. Cent. and cooling in air, a treatment which introduced an improvement associated with the atomic ordering of the iron and nickel atoms of the alloy. A modification of this treatment, known as the "magnetic anneal," consists of heating the material to a high temperature, then maintaining it for a short time between 400 deg. and 600 deg. Cent. under the influence of a magnetic field of several oersteds. The effect depends on composition and is most pronounced when the nickel content is between 60 and 70 per cent. After this treatment the maximum permeability is found to be greatly increased and the coercive force diminished. The hysteresis loops of the material which has been given a magnetic anneal have the characteristic rectangular shape shown in Fig. 2. The sides are almost vertical and the corners nearly square. The coercive force is much smaller than that of the same material heat treated in the absence of a magnetic field.

Modifications of the Permalloy composition

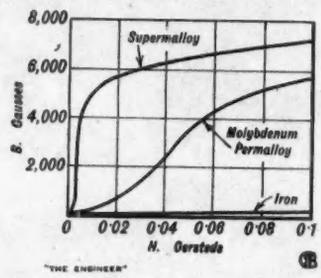


FIG. 4—*Magnetisation Curves at Low Field Strengths*

by the addition of one or more elements, such as chromium, molybdenum and copper, have given rise to Molybdenum-Permalloy, containing 4 per cent of molybdenum, Mumetal containing 2 per cent of chromium and 5 per cent of copper, and 1040 Alloy containing 3 per cent of molybdenum and 14 per cent of copper. Hipernik (50 : 50 nickel-iron) had the advantage over the 78 per cent Permalloy, which was specially suitable for transformers transmitting weak signals in communications apparatus, in having a high permeability in the higher magnetic fields used in the transmission of power.

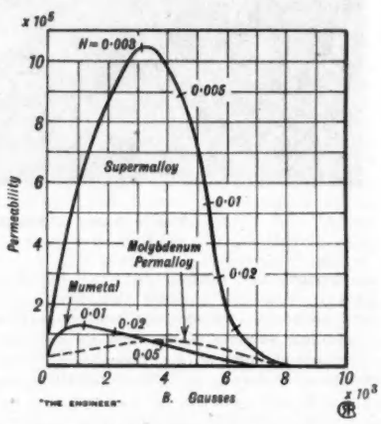


FIG. 5—*Permeability of Supermalloy, Mumetal and Molybdenum-Permalloy*

Another series of alloys, iron and cobalt, can attain greater intensity of magnetisation than either element alone. With fields of 1000 oersteds and below, the highest induction is obtained with the 50 : 50 alloy, Permandur. It is a useful component of the magnetic circuit of electro-magnets and permanent magnets in which it is used as yokes and pole-pieces. It is lacking in malleability, but with the addition of 2 per cent of vanadium, it can be rolled into thin sheets and used for diaphragms

Properties of High Permeability Alloys

Material.	Composition, per cent.	Heat treatment, deg. Cent.	Initial permeability.	Maximum permeability.	Coercive Force.	Saturation induction.	Resistivity microhm-cm.
Iron	99·9 Fe	900	200	5,000	1·0	21,500	10
Silicon-iron	4 Si, 96 Fe	800	400	7,000	0·6	19,700	59
Hipersil	3·3 Si, 96·7 Fe	1,200 H	1,500	40,000	0·1	20,000	48
Hipernik	50 Ni, 50 Fe	1,200 H	4,000	80,000	0·05	16,000	35
Permalloy	78·5 Ni, 21·5 Fe	1050/600	8,000	100,000	0·05	10,700	16
Mo-Permalloy	79 Ni, 4 Mo, 16 Fe	1,100	20,000	80,000	0·05	8,700	57
Mumetal	75 Ni, 2 Cr, 5 Cu, 18 Fe ...	1,100 H	20,000	110,000	0·03	7,200	60
1040 Alloy	72 Ni, 14 Cu, 3 Mo, 11 Fe	1,100 H	40,000	100,000	0·02	6,000	56
Supermalloy	79 Ni, 5 Mo, 15 Fe	1,300 H	100,000	800,000	0·004	8,000	60

H indicates treatment in hydrogen

* *Journal of Applied Physics*, February, 1947, vol. 18, pages 173 - 176.

† *Reviews of Modern Physics*, January 1947, vol. 19, pages 29–86.

of telephone receivers. The properties of the iron-cobalt alloys are nearer to those of iron than to those of the modern high permeability alloys. An alloy containing both nickel and cobalt (nickel 45 per cent, cobalt 25 per cent, iron 30 per cent), annealed at 1000 deg. Cent., and then for several hours at 350 deg. to 500 deg. Cent., has a constant permeability at low field strengths—hence, its name, Perminvar—and its hysteresis loss is extremely small (Fig. 2).

The properties of a number of these alloys, extracted from data given in Bozorth's most informative article, are summarised in the accompanying Table.

Supermalloy, the latest product derived from the Molybdenum-Permalloy type, contains nickel 79 per cent, molybdenum 5 per cent, iron 15 per cent, and manganese 0·5 per cent, all impurities being kept as low as possible. The alloy is melted *in vacuo* in 30 lb crucibles in a high frequency induction furnace, poured in nitrogen or helium at atmospheric pressure, and hot and cold rolled by

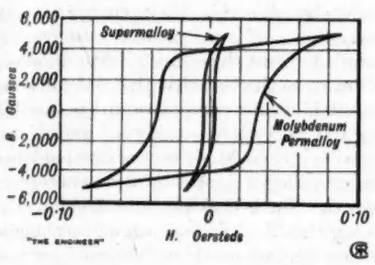


FIG. 6—*Hysteresis Curves of Supermalloy and Molybdenum-Permalloy (B max. = 5000)*

the usual commercial methods to 0·014in sheet or to tape of any thickness down to 0·00025in. The final heat treatment of the sheet or tape consists of maintaining the alloy at 1300 deg. Cent. in pure dry hydrogen and cooling through the temperature range 600 deg. to 300 deg. Cent., at a critical rate appropriate to the composition. The alloy appears to have an order-disorder transformation temperature somewhat above 500 deg. Cent. It is found necessary to cool at a definite rate below the temperature at which atomic ordering begins, or to hold the specimen for a definite time at a temperature between 400 deg. and 500 deg. Cent. Fig. 3 represents the magnetic properties of Supermalloy, in the form of 0·014in sheet, in comparison with Molybdenum-Permalloy and with iron at field strengths of up to 10 oersteds and Fig. 4 shows its high induction at low field strengths. Its high permeability under these conditions is shown in Fig. 5. In the form of 0·014in sheet Supermalloy has an initial permeability of 50,000 to 150,000, a maximum permeability of 600,000 to 1,200,000, a coercive force of 0·002 to 0·005 oersted, and a hysteresis loss of less than 5 ergs per cc per cycle at B 5000 (Fig. 6).

The high permeability of Supermalloy opens the way towards further improvements in transformers operating at frequencies common in commercial engineering in much the same way as the various modifications of Permalloy led to improvements ten to twenty years ago. The new material has, it is stated, already been made in considerable quantities for use in equipment supplied to the U.S. Navy.

Metallurgy at the International Congress for Pure and Applied Chemistry

ONE of the sections of the eleventh International Congress of Pure and Applied Chemistry, which met in London on July 17 to 24, 1947, was concerned with "Chemistry in relation to Metals." Although most of the thirty contributions in this section were of a very specialised character and of a definitely chemical nature, there were a number of papers of more than general interest.

Metallurgists concerned with the development of extraction processes will find inspiration and guidance in the deductions which, as shown particularly in papers by Dr. H. J. T. Ellingham and by Monsieur M. J. N. Pourbaix, can be made from recently acquired data on the free energy of formation of various classes of metallic compounds, especially at high temperatures. Diagrams in which free energy of formation of compounds of a particular class (*e.g.*, oxides) is plotted against temperature not only account for the success of well-known extraction processes, but permit quantitative assessment of the relative difficulty in obtaining the different metals by the reduction of a given class of compound at any selected temperature and, where any of the reactants is gaseous, at any specified pressure.

A session devoted to problems of corrosion was opened with a paper by Dr. U. R. Evans, who reviewed the now overwhelming quantitative evidence for the electrochemical mechanism of corrosion. The function of surface films in the prevention of corrosion was discussed by Dr. W. H. J. Vernon, the natural formation of protective films on aluminium and its alloys by Dr. F. A. Champion, of the British Aluminium Company's research laboratories, and a potentiometric method of deducing the composition of thin surface films on metals was described by Monsieur Jean Besson, of the Faculté des Sciences, Paris, while methods of combatting corrosion, involving the use of tin coatings, were dealt with by Dr. E. S. Hedges, who referred to the tinning of steel strip by electrodeposition, to the hot-tinning of cast iron after preliminary treatment of the surface with molten nitrates to remove the graphite smear, to the high resistance to corrosion of tin-zinc alloy coatings, and to the use of a very thin tin coating as an undercoat for paint which gives greater protection than either tin or paint alone. Finally, Monsieur M. J. N. Pourbaix dealt with the passivity of iron from the thermodynamical standpoint, and clearly showed the value of this method of approach to the problems of corrosion.

In the session devoted to electrodeposition and related electrochemical processes, British contributors were responsible for accounts of the practical advances made during the last few years, Mr. E. R. Dobbs dealing with electrodeposited anti-corrosion coatings and Mr. E. A. Ollard with electrodeposition processes in the more general sense, including the production of wear-resistant finishes, the building up of worn or under-machined parts, the manufacture of various components by electro-forming, and other special applications of electrodeposition. A paper on the electrochemical behaviour of metals in relation to anodic and cathodic polarisation, hydrogen over-voltage and deposition structure, on the basis of the ionic exchange rates, was presented by Professor R. Piontelli, of the University of Milan, who also gave a short review of the conditions of formation of "lead trees" in solutions of various compositions, concentrations and acidity. The periodic character of the dissolution of lead in aqueous solutions of chromic acid, as shown by regular oscillations of the potential between the values of 350mV and 450mV every 2½ to 7 seconds, due to the alternate formation and destruction of a chromate film, was discussed in a communication from Drs. M. Karsulin and B. Lovrecek, of the University of Zagreb, Yugoslavia.

In the session devoted to alloy constitution and behaviour, Dr. M. Cook in a paper read for him by Mr. W. H. Davis, summarised the effect of alloying elements on brass, referring to the pronounced increase in resistance to oxidation at elevated temperatures, and to many forms of corrosion shown by aluminium brass, and to the extensive use of this alloy for condenser tubes; to the good die-casting and welding properties of silicon brasses; to the resistance of dezincification of brass containing small amounts of arsenic or phosphorus; to the high-tensile brasses containing manganese, aluminium and iron, and also such elements as tin and nickel; and to the copper-zinc alloys with nickel and aluminium, nickel and silicon, or with beryllium, which are susceptible to temper-hardening. Work done in the Technische Hochschule, Vienna, on the enhanced deposition of metals through the formation of solid solutions formed the subject of a communication by Professor F. Halla and Drs. L. Egartner and R. F. Weil, who pointed out that a reaction like the reduction of sodium tungstate by hydrogen proceeds most readily in the presence of a metal which will form a solid solution with the reduced tungsten. The reaction is assisted by the formation of solid solutions of the newly reduced metal in the surface layer of the other. Experiments were described in which tungsten and molybdenum were deposited on iron bars and diffused into the surface. Professor Halla pointed out in a separate paper that at temperatures above A_3 the diffusion of these elements into iron is accompanied by the formation of columnar crystals, as was previously observed by R. F. Mehl for the diffusion of chromium into iron. Reheating and quenching caused recrystallisation with reduction in length of the columnar crystals.

The only paper relating to a steel product before the section was one by Dr. W. P. Rees and Mr. R. C. Gifkin, of the National Physical Laboratory, on stress-corrosion cracking in alloy steel for gas cylinders. The cylinders in question were made from nickel-chromium-molybdenum steel of between 60 and 70 tons per square inch tensile strength. Investigation into the cause of the premature failure of a number of these cylinders filled with either coal gas or hydrogen compressed to 200 atmospheres indicated that the failure had occurred by stress-corrosion cracking, the corroding medium being sulphur-containing compounds present as impurities in the compressed gas, together with water vapour. Experiments made on the steel used for the manufacture of these light cylinders showed that hydrogen sulphide, air and water vapour constituted a medium in which stress-corrosion of the steel would occur even when it was subjected to a stress as low as 10 tons per square inch. Carbon bisulphide and hydrocyanic acid also gave rise, in the presence of air and water, to stress-corrosion cracking, but the time for cracking to be initiated appeared to be longer than when hydrogen sulphide was the corrosive agent. In addition to the other reagents the presence of water or water vapour was necessary to produce the effect.

The final session of the section was devoted to metallurgical analysis and special reference was made by most of the contributors to the development of spectrographic, absorptiometric and other physical methods of analysis, and to the advances that had been made in their application during the last few years.

A complete report of the papers and discussions is to be issued by the Congress Committee at a later date.

Protection of Zinc Surfaces

APART from its use as a coating to protect steel, metallic zinc has long been recognised as having a good resistance to normal atmospheric influences, and its behaviour in this respect has put no obstacle in the way of the rapid expansion of the zinc alloy die casting industry.

There are, however, conditions of excessive moisture, and especially marine conditions, in which the formation of bulky, white corrosion products tends to occur and must be prevented. The need for surface protection of zinc alloy die castings has been evident ever since they were successfully introduced as a result of the appearance on the market of high-purity zinc, and the New Jersey Zinc Company developed the Cronak method of treatment ten years ago.

This treatment and some of its numerous alternatives are described in an article on "Chromate Finishes to Protect Zinc Surfaces," by George Black, in *Materials and Methods*, April, 1947, Vol. 25, page 113.

Although great improvements have been effected, there is evidently still room for further research and development before the resistance to corrosion of the zinc base alloys is entirely satisfactory in salt water conditions.

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NOTICE TO READERS

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THE OUTPUT OF THE MINES

THE five-day week in the Coal Mines of Great Britain has now been in operation for over two months, and the fears expressed before it came into action by those well qualified by knowledge and experience to entertain a sound view appear from the results to have been only too well-founded. The Coal Board, too, has now been in control for over six months. These two factors combined suggest to us the desirability of the nation taking stock of the situation, for there is no gainsaying the fact that the economic outlook for our country is in this respect very grave. For, as we have continued to press home in these columns, the undeniable fact exists that industrial production generally cannot rise until the output of coal is advanced beyond the present rate. For coal means power and without enhanced power-usage engineers cannot advance the output of labour. The significance of coal and its indispensability in our national economics were admirably described by Mr. Lloyd George when, as Minister of Munitions, he addressed the first Great National Mining Conference held in London on July 29, 1915: "In times of peace," he said, "coal is the most important element in the industrial life of this country. The blood which courses through the veins of industry in the country is made of distilled coal. In peace and in war, King Coal is paramount Lord of Industry. It enters into every article of consumption and utility; it is our real international coinage. When we buy goods, food, and raw materials abroad, we pay not in gold, but in coal." What has been said as to the bearing of the coal industry on other industries and the economic life of the United Kingdom is true of all great coal-producing and manufacturing countries of the world. The factories and main arteries of transport of such countries as Italy, Sweden, Norway and Denmark, countries unproductive of coal, are entirely dependent on other lands—chiefly, in the past on Great Britain—for their coal supplies, and, consequently, in large measure, for their commerce.

In the heyday of the coal trade's prosperity we had ample supplies of coal over and above those required to meet our internal demands, so that coal constituted our chief exportable commodity. Thus in 1913, the year of our maximum output, we exported no less than 73,400,118 tons (not taking into account foreign bunkers, coke and manufactured fuel). Last year we exported not one-tenth of that amount! In 1913 we raised 287,430,473 tons from our collieries, when they were not nearly as highly mechanised as they are at the present time. Last year the output was 100 million tons below this figure. Coal was cheap in 1913 (10s. 2d. per ton on the average). Now, though the average price for the year 1946 is not yet available, it has vastly increased. Miners' leaders and others asserted that the miners under a nationalised coal industry would give of their labour more freely and with greater goodwill than when working under private enterprise, but have the results justified the promise? Sporadic and unofficial strikes continue to occur, and abstention from work, which in the year 1939 was 6·4 per cent, and had risen in 1945 to 16·3 per cent, has shown little or no signs of diminishing. It was at such a time of critical coal shortage that the Coal Board thought well to introduce the five-day week, which, it was hoped, would be followed by a marked reduction in absenteeism, and that the Government's minimum coal target—a most inadequate minimum, be it said—of 200 million tons for the year 1947—would be more than achieved. But we now learn from the Chairman of the Board, when speaking to the miners at Rothesay on July 9th, that the Board's expectations are far from being realised. He said: "In many parts of the coalfield we are meeting with apathy and in some instances resistance to our attempts to get tasks reassessed. . . . Fewer men are now working the number of shifts they worked in May . . . The result is that the output has fallen, the current weekly rate is about 100,000 tons less than the week following the introduction of the five-day week. We are failing to justify the five-day week as a reasonable reform under existing circumstances." He stated that in order to achieve the Government's minimum target the miners would require to produce 11,000,000 tons more than last year, but up to the present "we have achieved less than 4,000,000 tons of this amount with half the year already gone." The outlook for next winter appears indeed grim. Even should the 200 million tons minimum be obtained, it would only suffice to meet the internal demand, and should any coal be exported it would be at the expense of home requirements.

The past history of the industry has shown that when a high rate of wages rules the absenteeism from work increases. Never were wages of the miners higher than at present and never has absenteeism been so great. There is no shutting our eyes to this disagreeable fact. There is another aspect of production which requires to be noticed. Coal is being delivered in a very dirty state perhaps because of the presence of an excessive quantity of surface coal. The admixture of shale and stone has certainly shown an increase in the coal now marketed as compared with that supplied pre-war. Factories, gasworks and electrical generating stations have their difficulties greatly increased by having to use dirty coal. This is a matter which should engage the attention of the National Coal Board. The miners would, by directing their energies to the production of a cleaner commodity, materially assist the country. Attention may be drawn to the fact that the coal consumed by public utility companies in the South of England is largely sea-borne, and if coal containing 15 to 20 per cent of dirt (and more has been alleged) is sent by steamers carrying from the North-East ports to London, then (seeing that the inherent ash and irreducible dirt in such coal should not exceed 5 per cent) from 10 to 15 per cent of the cargo space is taken up with dirt, which is of no practical use in the production of gas or electricity; or, in the case of land transport, the same proportion of each truck of coal is equally wasted, and this at a time when every ship, engine and wagon which could be made available is required for the carrying of foodstuffs and other substances of vital necessity to the nation. Plentiful and cheap fuel—the two are largely complementary—are essential if we are to maintain our commercial supremacy in the markets of the world, or if we are to ensure a decent standard of living to our people.

THE TECHNIQUE OF ATOMIC ENERGY CONTROL

IN the general interest of world security it is important that there should be an adequate measure of control in the development of atomic energy, international in form and, if possible, world-wide in scope. The abortive tripartite conference in Paris concerning the Marshall plan made many despair of getting the U.S.S.R. to co-operate in useful common action of any sort. The attitude of the U.S.S.R. delegation in the United Nations Atomic Energy Commission was, for most of the time, unyielding and unhelpful; indeed, the very idea of such a system of international inspection as that thought necessary by the Lilienthal Board of Consultants and later embodied in the First Report of the Atomic Energy Commission, was held to be incompatible with national sovereignty and was rejected. But, suddenly, on June 11th, last, Mr. Gromyko requested a meeting of the Commission to enable him to make a new statement on the Russian attitude; at this he announced, no doubt to the pleased surprise of the delegates, what seemed to be a complete change of attitude on the part of his Government. The U.S.S.R. now agreed that the mining of uranium or thorium

and every subsequent step of atomic energy production should be made under strict international control; that there should be set up an international inspectorate having the right to check existing stocks of raw materials, of mining facilities and production plants, with the right to make special investigations of any alleged violations of the accepted rules. Mr. Gromyko further proposed that the inspectors should have free access to all mining and production facilities and be allowed to measure, weigh and analyse both raw materials and finished products. He explained a few days later that there would be no question of any "veto" on these day-to-day operations of the Control Commission (more commonly known as ADA). ADA would, however, leave the exercise of any necessary discipline to the Security Council.

This remarkable change in attitude has made many wonder whether there may not, after all, be a fair chance of some common scheme of control being universally adopted. But it is not so generally realised that it still remains for engineers and chemists to undertake the necessary scrutiny of these new proposals and the assessment of their impact on the findings of the Atomic Energy Commission in its report to the Security Council of December last. That report, which was carried by ten votes out of twelve, the representatives of U.S.S.R. and Poland abstaining, has many features which need to be appraised more from a technical point of view than a political. It is for technicians to say what form of technical control and inspection is necessary in order to prevent the clandestine diversion of fissile materials to nefarious ends. When they have specified the essential technical precautions, there must be no subsequent whittling down of those requirements by the politically minded in order to facilitate agreement. Such an agreement, if so won, might be at the cost of the very security which forms the true objective. The U.S.S.R. proposals in their new form have been referred to a working committee of the A.E.C. and the result of its scrutiny will no doubt be seen in the Second Report, which the Commission is due to present to the Security Council in September. Whether this further report will be backed by all its twelve members remains to be seen. If it is the world will feel a safer place. If it is not there may be an opportunity for attempting to reconcile outstanding differences when the Foreign Secretaries meet in November. In the meantime, engineers interested in this new field of technical endeavour will no doubt examine for themselves the differences between the existing A.E.C. scheme and the subsequent U.S.S.R. proposals. They will notice a tendency in the latter to treat inspection as periodical rather than continuous (but if the periods are long the gaps will be large), and that no provision is made for ADA to manage and control those processes in which evasion, if not easy, is at least possible. The A.E.C., after receiving the technical report of the Kramers Committee, which received the backing of all its members, including the Russian, considered it essential that all types of large nuclear reactors should be built to ADA design, and would need in many cases to be managed by that Authority, as an appropriate safeguard. These are probably the chief differences that would strike an engineer, though there are others.

It is to be hoped that general agreement may be found possible, but whether agreement is reached or not the development of the new atomic fuel cannot be delayed. The rest of the world must, in any case, push on with its task, leaving it to any non-conforming nations to come into the scheme later on, when perhaps they will see for themselves that the interference with national sovereignty of the necessary control measures is not, after all, so considerable, and that the economic disadvantage to any country of standing out is very great.

Obituary

W. WELLESLEY WEAVER

MANY of our readers will learn with regret of the death recently, in London, of Mr. William Charles Wellesley Weaver, the chairman and, until two weeks ago the managing director of Waygood-Otis, Ltd., of Falmouth Road, London, S.E.1, specialists in lift and escalator engineering work.

Mr. Weaver was born in St. John's, Newfoundland, in 1890, and he received his education in this country. At the early age of sixteen he was apprenticed to the Waygood-Otis Company and he served it continuously during his working life, becoming one of the leading personalities in the lift industry. On the completion of his period of training he worked in all departments of the firm's business, and was responsible for carrying out lift engineering contracts not only in this country, but on the Continent of Europe and in Egypt. From 1914 to 1919 he saw service in King Edward's Horse Regiment, and at the close of that war he returned to London and became well known in both architectural and engineering circles. Later on Mr. Weaver spent some time in the United States, and he also represented his company in India and Australia. On his return to England in 1933 he was appointed managing director of the company. Since 1942 he has occupied the dual positions of chairman and managing director. Recently he paid a visit to South Africa, but he had been failing in health for some time, and about two weeks ago, on medical advice, he tendered his resignation as managing director. The board, accepting with regret his resignation, asked him to continue to serve as chairman of the company.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SCOTTISH RAILWAY NETWORK

SIR,—Whilst certainly I appreciate that your reviewer in the issue for June 20th dealt at considerable length with my new book, "The Scottish Railway Network," there is much that calls for a reply. How often have we not in recent years heard talk of "co-ordinating" train services, &c. So an essay at working out a network in which the trains do indeed all connect is fully justified. But where your reviewer condemns the inflexibility of the system proposed, it is on the score of my using even interval services, although such are extensively developed, for instance, by the Southern Railway, and are far from being any novelty. And where he lists various places—Stirling, Ayr, Hawick, &c.—as left out of the network, they certainly are not. For instance, the time from Edinburgh to Ayr would become 1 h. 45 min., available every hour, as against the present best time of 2 h. 45 min. Again, from Hawick to Glasgow the time would become 1 h. 40 min., available every hour, as against the present best time of 3 h. 15 min.

The purpose of the new network principles is to realise a good timing from every place to every other, and this ideal is so far realised that no town can escape having large improvements in the various timings to other places therefrom.

I should like to stress the great generality of timing improvement with an hour section network, by reference to the accompanying sketch.

This shows a simple scheme of four-hour sections in the Midlands. The hour-section rules are briefly: every hour on the hour an express train leaves A for B, arriving eight minutes short of the next hour, a stopping train leaves A hourly two minutes past the hour and arrives at B twelve minutes short of the two hours later. Oppositely-going trains run similarly. The hour sections shown range 48 miles to 53 miles long, and are planned by connecting up existing lines, but to be clear of principal main lines.

Anyone familiar with travelling in the Midlands will perceive how far the timings represented improve on those existing. For instance, the hour express 52 min. from Stoke-on-Trent to Nottingham compares with the pre-war best time during the day of 1 h. 37 min. The intermediately served places all share the improvement; thus, Northwich to Nottingham, about 1 h. 45 min.; Uttoxeter to Liverpool, 1 h. 40 min. In short, the travel wearied Midlander would infinitely prefer to see this network reconstruction treated neither as absurd or humorous, but as a serious proposition.

J. F. POWNALL.

Birmingham, July 14th.

SCIENCE, LIBERTY AND PEACE

SIR,—Mr. Felton's letter in your issue for July 11th appears to be very reasonable and his commendation of Mr. Huxley's "Ends and Means" is admirable, but it appears to me that Mr. Felton is, in turn, responsible from the opposite point of view, for the same fallacy which he lays at the door of the technician. It is quite true that technical progress will not improve human behaviour or human welfare of itself, but it is equally true that it is not responsible for any deterioration in human behaviour or human welfare. Technique and humanity are, in fact, like beauty and utility, quite distinct aspects of a problem, and while it is a very common error to blame the one for the qualities of the other, and frequently true that they do affect each other, it is not true that they are bound to do so.

Human behaviour can be just as good or bad under so-called modern conditions as it has been in the past and it will not improve human behaviour to allege that it is made good or bad by any technical changes which have occurred, or which may occur in the future.

H. G. P. TAYLOR

Shoreham-by-Sea, July 21st.

F. W. Webb's First Four-Cylinder Compound Engine

By E. C. POULTNEY, O.B.E., M.I.Loco.E.

FIFTY years ago—July, 1897—the engine "Black Prince," No. 1502, was completed at the Crewe Works of the London and North Western Railway. Designed by Francis William Webb, this celebrated locomotive, destined to become the first of forty of the class, struck a new note in Crewe practice, signalling, as it did, a definite departure in design compared with the former three-cylinder compound express passenger engines.

As a preliminary step—at least, so it would seem—a similar locomotive had already appeared in June of the same year, but having four simple expansion cylinders. This was the "Iron Duke," No. 1501, distinguished by being the first engine of the 4–4–0 type to be built at Crewe.

Though the "Iron Duke" had little influence on Crewe practice, it was, nevertheless, an interesting design for, apart from having four simple expansion cylinders, each 15in by 24in, it also had a novel form of smoke-box, divided longitudinally by a horizontal diaphragm plate with a double chimney and two blast pipes, one of which evacuated the lower portion of the smoke-box and the other the upper. This was accomplished by extending one half of the chimney downwards into the smoke-box, so that it would open into the lower part, while the other half opened into the upper section, and fitting twin blast pipes, one for the upper and one for the lower section of the smoke-box.

This arrangement, the subject of a patent, No. 29240 of 1896, granted to Webb, was intended to equalise the draught over the tube nest. It does not, however, seem to have been considered a success and was ultimately abandoned.

A further patent of Webb's, obtained in the same year, No. 29239, was of greater practical value and, therefore, more interesting. This had for its object the operating of the four valves of a four-cylinder engine by two sets of valve gear only. In describing this, the writer cannot do better than quote in part Webb's own description of his compound engine of the "Black Prince" class, as given by a paper on "Compound Locomotives," read at the Engineering Conference of the Institution of Civil Engineers, June, 1899.

"These engines, unlike the other compounds previously built, have two high-pressure and two low-pressure cylinders, with a boiler pressure of 200 lb per square inch. The former cylinders are 15in in diameter and the latter 20½in in diameter, both having a stroke of 24in. They are all placed in line, and drive on to one axle, this axle being coupled to the trailing axle behind the fire-box. A feature of these engines is the method devised for working the valves, two sets of valve gear only being required for working the four valves. The valve gear used is Joy's, which is applied to the low-pressure cylinders in the usual way. The low-pressure valve spindles are prolonged through the front of the valve chests, and each spindle is coupled up to a lever of the first order, which is carried on a pivot securely fixed to the frame, and the other end of the lever being connected to the high-pressure valve spindle. Thus, the high-pressure valves are worked from the low-pressure motion, through the intervention of the lever, which is so proportioned as to give the required travel to the high-pressure valve."

The design of these levers is novel and the sketches reproduced are based on those given in the patent specification. The interesting feature is the means adopted for coupling the ends of the lever to the valve spindles. It will be seen that the spindles are fitted with crossheads which carry circular blocks slotted to receive the ends of the lever forked for the purpose. From this construction it will be noted that the lever, is directly connected to the valve spindles, yet allowance is at the same time made for the arcs described by the ends of the lever through their sliding action in the blocks turning freely in the valve spindle crossheads. This shows, at any rate, substantially, the design of lever used by Webb for all the four-cylinder compounds and also as fitted years later by C. J. Bowen Cooke to his four-cylinder "Claughton" class locomotives, designed in 1913.

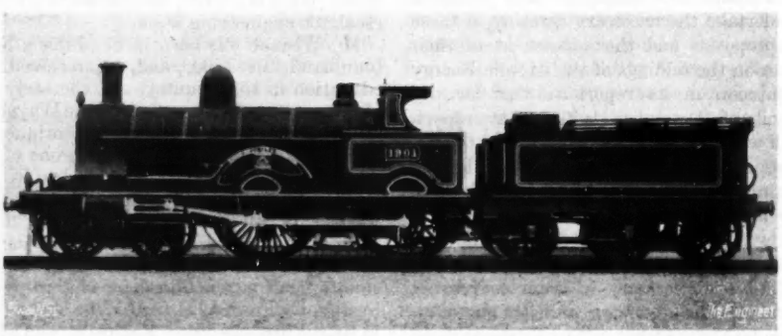
L.N.W.R. Four-cylinder Compound Locomotive, "Black Prince" class.—Principal dimensions:

Cylinders :—	
2 h.p.	15in dia. by 24in stroke
2 l.p.	20½in dia. by 24in stroke
Wheels :—	
Driving and trailing ...	7ft 1in dia.
Radial truck	3ft 9in dia.
Wheel base :—	
Centre of radial truck to centre of driving wheels	10ft 4½in
Centre of driving wheels to centre of trailing wheels	9ft 8in
Total wheel base ...	23ft 2in
Boiler :—	
Dia. of barrel outside ...	4ft 2½in
Length of barrel	10ft 11⅛in
Length of fire-box, outside	6ft 10in
Width of fire-box, outside	3ft 11in
No. of tubes	225
Dia. of tubes	1⅝in
Steam pressure	200 lb per square inch
Heating surfaces :—	
Tubes	1241·3 square feet
Fire-box	159·1 square feet
Total	1400·4 square feet
Grate area	20·5 square feet
Weight in working order :—	
On coupled wheels ...	35·5 tons
Engine total	54·4 tons
Tender	26·6 tons
Total	81·0 tons

The other sketch shows an alternative arrangement, comprising a lever with a slotted centre into which a block is fitted, carrying the pivot centre. The idea of this arrangement was to provide means in a compound engine to vary the travel of one valve relatively to the other by shifting the position of the fulcrum by means of a screw or other form of gear. This arrangement, though never used so far as the writer is aware, is particularly interesting, indicating, as it does, that Webb was not unmindful of the possible advantage of being able to vary the h.p. and l.p. cut-offs independently.

Webb Four-cylinder Compound Locomotive, "Iron Duke," No. 1903.—Particulars of run from London (Euston) to Crewe, June 8, 1899; Institution of Civil Engineers' Special train.—Composition and weight of train:*

Engine and tender	81·0 tons
Dynamometer car	11·0 tons
Twelve 45ft coaches One 50ft 2nd class brake	318·25 tons
Total weight	410·25 tons
Distance, miles	159
Mean speed, m.p.h.	50
Coal consumed, tons ...	3·1
Water consumed, gallons	5248·5
Water evaporation, per lb of coal	7·8 lb
Consumption of coal, lb per mile	43·7
Maximum pull on drawbar at starting, tons	4·75
Maximum pull on drawbar whilst running, tons ...	5·25
Maximum speed, m.p.h. ...	71



L.N.E.R. "BLACK PRINCE" CLASS LOCOMOTIVE "DIAMOND JUBILEE"

Both the "Iron Duke" and the "Black Prince" were fitted with boilers duplicating with those used for the "Teutonic" class three-cylinder compounds, having a total heating surface of 1401 square feet and carrying the same working steam pressure of 175 lb per square inch. Further, when first turned out, "Black Prince" had 19½in l.p. cylinders; so, also, had the "Iron Duke," when later converted to compound expansion.

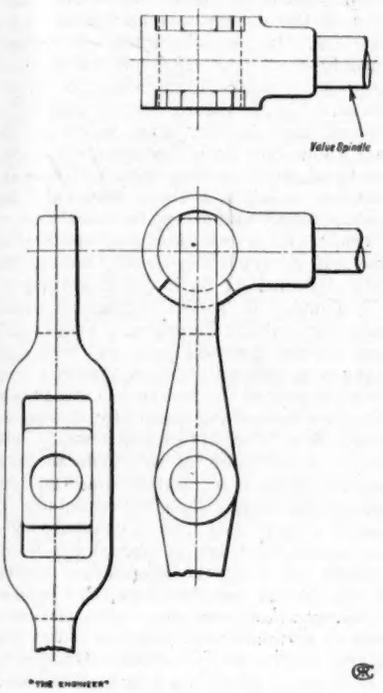
After some little time, however, the l.p. cylinders were enlarged to 20½in, and the steam pressure was also increased to 200 lb per square inch. For steam distribution, the h.p. cylinders had piston valves, and the l.p. cylinders were fitted with Richardson semi-balanced slide valves. The h.p. cylinders were placed outside and the l.p. cylinders between the frames, the crank-pins for adjacent inside and outside cylinders being on opposite centres.

Beyond the valve gear arrangement already described, these engines possessed other interesting mechanical features; thus, the crank axles were of the built-up pattern, constituting one of the early uses of this construction, at any rate for extensive applications. The crank pins were hollow-bored and the webs extended to form balance weights.

Due to the employment of Joy's valve motion and the consequent suppression of eccentrics, the central bearing for the crank axle between the cranks—a feature of the "18in" 0–6–0 fast goods class of 1880 was reintroduced. This provided a

* "Modern Types of British Locomotives," C. J. Bowen Cooke, *Cassier's Magazine*, July, 1901.

bearing 7in in diameter by 5½in, additional to the main journals 7in diameter by 9in long. The central bearing was housed in a casting extending from the motion plate to the stretcher in front of the fire-box. The wheel centres had large circular hubs containing the required balance weights, which were, therefore, not formed in the rim of the wheels, as usual. One further feature of moment was the leading four-wheeled truck. For many years Webb held firmly to his two-wheeled radial axle and, in designing the four-wheeled truck, he still maintained the same principle. The Webb truck (it was officially called a "Double Radial Truck") had the usual



VALVE LEVER CONNECTIONS

side frames and these were connected together by curved transverse guides. These carried the weight through a pivot centre much like the normal Adams arrangement, but the truck—it could hardly be termed a bogie, which, in fact, was not allowed—did not turn about the centre, but simply had a transverse movement in a curved path when entering curves in the track, thus assimilating the action of a radial axle-box, whether working between curved guides, as in the Webb pattern, or swinging by means of a radius bar about a fixed centre. Inverted, laminated springs and equalising beams of the normal type were fitted to take the weight, and coil check springs controlled the transverse movement.

As already mentioned, the original "Iron Duke" was converted to compound expansion in 1898 Later, another "Iron Duke" was built, in 1899, numbered 1503, and later renumbered 1903. The original "Iron Duke" of 1897, No. 1501, was, after compounding, ultimately renamed "Diamond Jubilee" and, in 1899, given the number 1901. It is this engine which is illustrated.

The compound engine, No. 1903, "Iron Duke," was used to work a special train from London to Crewe and return on June 8th, 1899, taking members of the "Institution of Civil Engineers" on a visit to the Crewe Works on the occasion when Webb read his paper on "Compound Locomotives," to which a reference has been made. The leading dimensions of these "Black Prince" class locomotives are given herewith, as are also particulars of the performance of the "Iron Duke" on the "down" journey with the special train from London to Crewe.

While the "Black Prince" class compounds have had their fair share of criticism, they, even so, depict a design of some importance. They represent the first large adoption of the use of four cylinders since a distinguishing feature of modern British practice; further, the built-up crank axles and the relatively high steam pressure of 200 lb per square inch, not to mention the method adopted for connecting the motion from one set of primary valve gear to two valve spindles, are additional features in which the design portrayed more modern construction. The photograph reproduced has been supplied by the Locomotive Publishing Company.

Iron and Steel Institute

No. I

THE Summer Meeting of the Iron and Steel Institute was this year held in Zurich, Switzerland, on July 9th and following days. There were technical discussions on July 10th and 11th, and a number of visits to places of interest had been arranged. Below we print abstracts of the discussions at the technical sessions.

The opening technical session was held in the great hall of the Swiss Polytechnic in Zürich on Thursday, July 10, 1947. Dr. C. H. Desch, F.R.S., President of the Institute, took the chair.

Dr. A. Rohn, President of the Swiss Technical School Council, offered a cordial welcome to the Institute, to which Dr. Desch replied. The following papers were then presented and discussed together:—"Electric Smelting" and "The Production of Iron and Steel with Oxygen-Enriched Blast," by Professor Dr. R. Durrer, and also "Possibilities for the Extended Use of Oxygen in the British Steel Industry," by M. W. Thring.

THE PRODUCTION OF IRON AND STEEL WITH OXYGEN-ENRICHED BLAST[1]

By R. Durrer[2]

Synopsis

The possibility of using oxygen-enriched blast for iron-ore smelting and for steel-making by the Bessemer process is considered, particular reference being given to the economic conditions. Modifications of blast-furnace and converter design and of current practice which would be necessitated by the application of oxygen-enriched blast are briefly outlined. The development of a combined smelting-converting process using oxygen-enriched blast is envisaged.

ELECTRIC SMELTING[3]

By R. Durrer[4]

Synopsis

The development of electric smelting furnaces is outlined, with special reference to the low-shaft furnace. The reactions taking place in electric smelting are discussed and compared with those of the blast-furnace, particular consideration being given to the energy consumption in the two types of furnace. In conclusion the possibilities of the future development of electric smelting are considered.

Discussion

Mr. R. Mather (Skinningrove Iron Company, Ltd.) felt that the use of oxygen in the blast-furnace was one of the ways in which blast-furnace practice was going to develop, on steady and more or less expected lines. The introduction of a somewhat higher percentage of oxygen in the blast was a fairly logical and not a very revolutionary step. He thought that in the next ten to twenty years positive developments would take place in that direction, and there was no reason why those developments should not be combined with those in the other direction in which blast-furnace development was taking place to-day—the use of high top pressures, about which information based on actual operating practice was beginning to be received. Mr. Thring had referred to the difficulty of getting someone to start using oxygen on a substantial scale. Personally, when in America just over twelve months ago, he saw a very large oxygen plant being built at one of the large American steelworks. It was nearing the stage when it would be ready for operation, but whether it had since been put into operation he did not know. It was a fact, however, that in America very large oxygen plants were being built.

Mr. Thring pointed out that the use of oxygen in the steel-making process would have considerable advantages in three or four directions so far as the Bessemer process was concerned. The points to which Mr. Thring called attention were substantial, but another point which might be of still greater use and just as feasible would be the possibility of using the Bessemer process for pig irons of intermediate composition between the only two ranges of composition for which that process could now be used, namely, the low-phosphorus, hematite-making, acid Bessemer, which had almost disappeared except for a little in the U.S.A., and the very high phosphorus pig iron, of 1·7 per cent, 1·8 per cent and over. It was not possible to-day to use the basic Bessemer process for irons of intermediate phosphorus composition, which at any rate in England formed very much the greater part of the basic iron which was available. One reason for that limitation so far as the basic Bessemer process was concerned was that with the intermediate phosphorus contents of 0·7 to 1 per cent there was not enough heat available, but with oxygen in the blast it would be possible to get a hotter metal, so that it might be feasible to consider the use of the basic Bessemer process.

Mr. E. C. Evans (London) said that blast-furnace managers might remember that over twelve years ago the Blast-Furnace Committee of the Iron and Steel Federation issued a report on the possibilities of oxygen in blast-furnace practice. The conclusion to which they came at the time was that it would not pay in Great Britain for pig iron production, but that it would pay for ferro-manganese or special alloy production. That conclusion was based on the then price of coke, and the cost of oxygen from the plants then working. To-day the position had entirely changed. Coke costs had increased considerably, while on the other hand recent developments in oxygen production had reduced the cost of oxygen to a considerable extent. The cost of oxygen was made up of two main factors, power cost and capital charges, those factors being approximately equal. If it was possible to reduce both, the possibilities of using oxygen became much more attractive. That could be done by building big oxygen plants; the cost went

[1] Received March 20, 1947.
[2] Gesellschaft der Ludwig von Roll'schen Eisenwerke, A.G., Gerlafingen, Switzerland.
[3] Received March 17, 1947.
[4] Gesellschaft der Ludwig von Roll'schen Eisenwerke, A.G., Gerlafingen, Switzerland.

down almost in a hyperbolic curve as the quantity of oxygen increased.

There were two main lines of attack in America. One was the use of oxygen for combustion, and in that direction a few companies had obtained some very interesting results. With oil as the fuel, almost any modification of the oil burner to allow the introduction of oxygen produced useful results, and, adding the oxygenated air or oxygen blast during the melting-down period, they had been able to increase production by something of the order of 30 per cent with no greater wear and tear on the refractories; in fact, refractory life, expressed as the number of heats, had in one works been actually increased. The other line of development was the use of oxygen in the bath. For low carbon steels that had given most valuable results, the increase in output being of the order of 30 to 33 per cent. One works, which had "gone the whole hog" and introduced oxygen into the combustion air and into the bath, had reduced the time of melting from tap to tap from 11½ hours to a little over six hours, which meant a tremendous increase in output.

Dr. Magnus Tigerschiöld (Jernkontoret, Stockholm) said that one fact which had not been mentioned, but which he had seen in a Canadian paper, was that at a big plant making non-ferrous metals at Trail in Canada large-scale experiments had been carried out using oxygen and steam in a gas producer, and in an ordinary gas producer with revolving grates they got from an ordinary coal gas of 2500 calories/cubic metre which was very easy to make. It was possible to use just an ordinary gas producer and get that very rich gas. That way of using oxygen had the great advantage that one also used the oxygen in the steam and enriched the gas in that way. The next step must be to try to make a gas producer with a hearth where one would melt one's slag, and the next would be to put some oxygen into that gas producer in the form of ore, and then by adding a little more ore one would end up with the low-shaft furnace which Dr. Durrer prophesied. He thought that that was one line of development.

Dr. L. Jenicek (Czechoslovak National Steel Corporation) did not believe that the use of oxygen in the blast-furnace would be of general interest, and the low-shaft furnace seemed to him not very possible in practice. But there were other possibilities, and in particular its use in the Bessemer process and in the open-hearth furnace was of great interest. Moreover, the production of rich gas from an inferior coal was important. He thought that metallurgists should be interested in such gas producers as the Lurzi, in which the oxygen was used under a pressure of 20 atmospheres and in which the solid fuel was completely gasified. On that point he could not agree with Mr. Thring; he thought that the possibilities were extremely interesting. The most important factor, however, in deciding whether oxygen would be largely used was its price. It was calculated in his country that a cubic metre of pure oxygen produced in Linde-Fraeure installations cost ½d. It was not cheap enough for producing a good town's gas from lignite. The costs of the installation were not low. It was to be hoped that new principles of construction would be used.

Mr. A. G. Robiette (John Miles and Partners (London), Ltd.) endorsed Dr. Durrer's remark that if an oxygen-rich mixture was used for blowing the blast-furnace it was conceivable that one would end up with a furnace which did not look like a blast-furnace at all. Personally, he thought that that fact was fundamental and that it must be realised that the use of oxygen brought in an entirely new set of physical conditions and would upset all previous ideas of what iron and steel plant looked like. That was where the Germans went wrong when they tried to push oxygen into the bottom of a Bessemer converter. They increased the oxygen content until the refractories failed. The Americans, in his opinion, were making the same mistake in applying oxygen to existing open-hearth furnaces, where neither the process nor the receptacle was designed for the use of that medium. He did not mean to imply that no advantage would be gained by so doing, but it disregarded the fundamental advantages which the use of high oxygen mixtures would bring to steel-making practice.

In his opinion, the main application to steel-making should be the blowing of pig iron with oxygen for conversion into steel. This had three advantages, as Mr. Thring pointed out. In the first place, it was possible to melt between 25 and 30 per cent of the total charge in steel scrap; in other words, the circulating scrap in an integrated steelworks was completely absorbed without the necessity for any other type of steel-making equipment, so that instead of using it as an adjunct to the open-hearth it replaced the open-hearth. Then, as Mr. Mather had pointed out, any composition of pig iron could be blown, irrespective of the content of heat-forming elements. A pig iron had been blown with pure carbon and steel made from it. The third advantage was that low-nitrogen steels were obtained; steels had been produced which were lower in nitrogen than ordinary open-hearth quality material. The use of oxygen would thus enable the open-hearth furnace to be largely replaced, with an enormous saving in fuel.

He and his colleagues had been working on this process for some years, and it was proposed that they should present a paper to the Institute on the subject in a few months' time, and he did not want to anticipate its subject matter; but he could say that they had blown heats with 90 per cent oxygen on a scale of 2 tons at a time and in a period of approximately thirty minutes, and had produced steel some of which had gone into commercial products. That conversion had been effected, as he had said, in about thirty minutes, and as a result of their experience he regarded such statements as that of Kapitza, of conversion in one minute, as completely fantastic; it was only necessary to calculate the volume of gas given off by a ton of pig iron in that period to appreciate what would be likely to happen to the steel. Arrangements were now being made to carry out the process on a large scale with vessels of 10 tons capacity. This would prove, he believed, to be one of the major developments in the iron and steel industry.

Mr. F. G. Kerry (Canadian Liquid Air Company, Montreal) said that a little over a year ago, when the Steel Company of Canada tried out its first test in an open-hearth furnace, it did not do so in order to study the mathematics or the academics of the furnace with oxygen, but rather to find an answer to a very serious problem which had to be faced elsewhere also, the problem of rising production costs. Their idea was to reduce production costs by increasing the production of steel per hour and per furnace. Obviously the way to do that was to increase the charge and increase the fuel rate per hour.

To burn fuel in a very quick manner it was necessary to use something more than just air. To enrich the air through the recuperators was not the answer; the furnace would not stand the heat, as they had found after many tests. If, however, one used almost pure oxygen through the burner to give the primary combustion, it was possible to increase the fuel rate (he was speaking now of oil) by as much as 45 per cent. This would give increased production, and, speaking rather conservatively, they felt that they could increase the production of their open-hearth furnaces by at least 30 per cent. Moreover, although the fuel rate was increased by as much as 45 per cent during the melting down period, there could actually be a gain in fuel. It was possible to knock it down by as much as 25 per cent. That, however, was not always the case; it applied to open-hearth furnaces in which 40 to 50 per cent of the charge was hot metal or hot pig iron. In furnaces where one charged entirely scrap, the effect on the fuel consumption was not as interesting, for obvious reasons. With regard to the amount of oxygen used, a very good figure to take was about 850 cubic feet per ton of steel produced, when dealing with half cold and half hot metal, and about 1000 cubic feet per ton for all cold charge furnaces.

One of the most interesting applications was not so much the fusion, because this depended entirely on low-cost oxygen, but the blowing of oxygen through a molten bath for refining purposes. They found, after several thousand tests, that they could apply commercially pure oxygen at current prices in view of the fact that it was possible to reduce the refining period by at least one hour. Even in small furnaces it was possible to get a reduction of as much as three-quarters of an hour, and at times an hour. One of the most interesting aspects of the matter was the fact that in countries where the charge was high in phosphorus it was possible to bring the phosphorus content down. Recent tests had shown that by blowing oxygen there was more intimate contact between hot metal and slag, and it was possible to reduce the phosphorus to 0·006 per cent, starting off from a very high content.

He agreed with Dr. Durrer that it was necessary to stop thinking in terms of oxygen enrichment and nitrogen elimination and start thinking in terms of oxygen as applied to basic chemical reactions. It was also necessary to stop thinking in terms of applying oxygen to standard equipment; modifications would have to be made. At the same time, it would be realised that it was not possible to take an open-hearth furnace costing about a million dollars and replace it; steel companies were rather conservative and just did not do things in that way.

Mr. A. Robinson (Appleby-Frodingham Steel Company) had been particularly interested in Dr. Durrer's suggestions regarding the future steel furnace; he could envisage considerable alterations being made eventually, if the oxygen was cheap enough. The use of oxygen in the refining of the steel would depend entirely on the relative cost of the oxygen, the charge—the figure in the charge which would give the heat—and the cost of fuel, and also, perhaps, the cost of the refractories. At the moment, iron ore was used to give the oxygen required, and that gave a certain amount of iron which was rather cheap iron. The use of oxygen in the blast-furnace offered very interesting possibilities in England, because in England they had mostly very soft ores, and in many districts very soft cokes. If it was possible to have a low blast-furnace and avoid the cost of the extremely expensive pre-preparation plants which were being installed, the saving might pay for the oxygen plant.

(To be continued)

Electronic Measuring Equipment for Aeronautical Research

AN exhibition arranged by the Instrumentation Department of the Royal Aircraft Establishment was held at Farnborough from July 21st to 24th inclusive, to demonstrate the potentialities of electronic measuring equipment which, as the result of development work undertaken or initiated by the R.A.E., is soon to become available from British manufacturers.

For a number of reasons, which are indicated below, electronic apparatus, indicating or recording, is convenient, if not indispensable, for measuring certain quantities in aeronautical research and development work. In the first place, the pick-up, which provides an electrical signal proportional to the quantity to be measured and is the only part of the equipment which must be installed at the point of measurement, can be small and light. Secondly, the electrical signal can be transmitted conveniently for remote indication or recording. Thirdly, the pick-up responds to rapidly varying quantities; its natural frequency can be made high because the sensitivity thereby lost is easily regained by electronic amplification; similarly, the natural frequency of the galvanometer may be made high, if a cathode ray tube is not used. Finally, simultaneous recording on the same time base from a number of pick-up points is simplified.

Although the equipment exhibited was designed primarily for the needs of work on the characteristics of aircraft structures and power plant, the possible field of application is evidently very much wider, embracing any particular investigations that involve the measurement of acceleration, pressure, strain and vibration. For the sake of completeness the exhibits included a few items of non-electronic equipment developed recently by the Instrumentation Department of the R.A.E. Of the thirty exhibits shown, only a small selection are referred to in the brief account that follows.

Pick-Ups

Among the more interesting sections of the exhibition were those devoted to a variety of pick-ups which form the basis of any electronic measuring system. The vibration pick-ups included a seismic generator pick-up with an undamped natural frequency of 15 cycles per second and a sensitivity of 0.5V per inch per second.

Acceleration pick-ups included resistance, inductance and capacitance types having various characteristics. An interesting development in this group is a vacuum tube pick-up (Mullard Wireless Service Company, Ltd.), consisting of a double diode with the two anodes elastically mounted and moving with respect to the cathode under the impressed acceleration.

Pressure pick-ups were displayed, using resistance, inductance, capacitance and piezo-electric effects, the last mentioned being designed for the measurement of blast pressure effects. The wire resistance strain gauge lends itself very readily to the measurement of load. One of the examples shown is designed to measure loads up to 10 tons. The measuring element is a short hollow cylinder in compression longitudinally and fitted with a system of longitudinal and transverse wire resistance strain gauges which make up the measuring and temperature compensating elements of a Wheatstone Bridge circuit. Combined with suitable ancillary apparatus the accuracy of this type of dynamometer is of the order of one part in a thousand.

Multi-Channel Recording Equipment

One of the equipments exhibited for ground recording was the six-channel cathode ray tube camera recording equipment which is designed for multi-channel recording on paper using resistance, capacitance, inductance or generator pick-ups for laboratory and field tests. The equipment consists of four main units. The first unit, the main tube and camera assembly, comprises six 3½in blue luminiscent cathode ray tubes, arranged for photography in conjunction with a combined drum and continuous-feed camera having ten paper speeds, and complete with six amplifiers. An input unit (with provision for selecting from forty-eight pick-up points, in groups of six), a power unit and a capacitance and inductance pre-circuit unit complete the equipment. The first three units are manufactured by Cinema Television, Ltd., and the fourth unit by Southern Instruments, Ltd.

This equipment was demonstrated to show the measurement of strain with wire resistance strain units and the measurement of vibration with generator pick-ups in a tail plane excited in a test frame.

For making comparable measurements in flight a six-channel galvanometer-camera recording equipment, made by Savage and Parsons, Ltd., was demonstrated. This equipment is intended for use with resistance and generator pick-ups in the frequency range 1 to 1000 cycles per second. The recording oscillograph accommodates seven oil-damped vibrator galvanometers, and 100ft of 120mm film or paper driven at 0.5in to 50in per second in five steps. A voltage generator provides time trace signals and a sinusoidal calibrating signal. The equipment includes three pairs of amplifiers and pre-circuits for the connection and selection, in groups of six, of forty-eight generator units, or forty-eight pairs of resistance units.

Four-Way Cathode Ray Equipment

Another exhibit, the four-way cathode ray tube equipment made by Industrial Electronics, Ltd., is intended to fulfil the requirements for the simultaneous measurement of signals from several resistance strain unit bridges used in structural investigation on aircraft in flight.

Each strain unit bridge output is connected in turn by means of a high-speed rotary switch, to an amplifier and thence to the deflector plates of a cathode ray tube. To avoid the confusion resulting from all signals appearing about a common base line, Y-shift potentials are applied to provide a definite horizontal position for each bridge signal channel. A rotary switch speed corresponding to a switching frequency of 100 times per second provides adequate definition for signal frequencies from 0 to 20 cycles per second.

Included in the control box are suitable signal attenuators, a micro-ammeter for gauge continuity testing and bridge balancing when used in conjunction with a bridge selection switch, bridge voltage meter and control. Provision is made for calibration of the bridge circuits and external metering. A half-second time mark, for use with a recording camera, is obtained from a built-in clockwork contact mechanism.

The principle of operation and frequency response of this equipment were demonstrated by injecting a sinusoidal signal from an oscillator.

600-Way Static Strain Recording Equipment

An interesting exhibit was that of a prototype equipment (made by Savage and Parsons, Ltd.) which is capable of recording up to 600 steady strain gauge signals in about five seconds and has been used extensively in the investigation of problems of stress distribution in aircraft components under static strength tests. The advantage of such an apparatus is the great saving of time and manpower during an actual test if the number of operating gauges exceeds 250.

The apparatus consists of a number of Post Office selector switches operating in conjunction with a high-speed rotary switch, cathode ray tube and camera. The whole will be built into a semi-portable unit for use in the laboratory.

The strain gauge bridge circuits are arranged in self-contained groups of eight, output and common bus-bar leads being brought into eighteen pin plugs. The output leads are connected to individual balance potentiometers and the bus-bars to on-off switches to make possible isolation of each group. Calibration groups consisting of single bridges, are arranged so that calibrating signals are obtained automatically from eight tappings on a chain of fixed resistors connected between the gauge arms of the bridge.

Output signals from the bridge are selected three groups at a time by three eight-pole, twenty-five-way Post Office selector switches, transmitted to the one-pole, twenty-four-way rotary switch and in turn passed on to the amplifier and cathode ray tube, where they are photographed on continuously moving film. The selector switches are operated, step-by-step, by a contact every four revolutions of the rotary switch.

Manual selection of bridge circuits is provided for testing the installation. A separate monitor cathode ray tube will be included so that the traces can be easily observed during recording.

Electronic Torquemeter

The electronic torquemeter made by McMichael Radio, Ltd., indicates the torque transmitted through a rotating shaft by measuring the angular twist of the shaft over a fixed gauge length. Two identical a.c. generators are attached to the shaft. Each generator consists of a toothed wheel rigidly fixed to the shaft, and an electro-magnetic pick-up fixed in space near the wheel periphery.

Torque in the shaft gives rise to a circumferential displacement between the wheels, and hence to a phase displacement between the two generator e.m.f.s. The torque and the phase difference are linearly related. The phase displacement is measured electronically, the measurement being sensibly independent of the frequency, amplitude and wave-shape of the e.m.f.s. obtained from the pick-ups.

Steady torque is indicated on a calibrated milliammeter and torsional oscillation can be recorded by connecting the output to a cathode ray oscillograph. The demonstration model is an airborne version which has been used successfully on Merlin engines. The error is about ±1 per cent of full scale.

Transmitting Accelerometer

This is a general purpose transmitting accelerometer which in conjunction with a Desynn indicator and an automatic observer, or with a Desynn recorder, is used to measure aircraft linear accelerations.

The accelerometer utilises the well-known damped mass-spring system. The mass is connected to a miniature Desynn transmitter Mk. IA by means of a simple lever system, and it is split into two halves which are clamped together under spring tension so that the mass has only freedom to slide along two parallel rollers. Felt pads are placed between the mass and the rollers to increase the friction, but the rollers are driven at high speed in opposite directions through gearing by an electric motor. It can be shown that under these conditions the frictional force opposing the motion of the mass along the rollers is proportional to the velocity of the mass and thus provides effective damping. The amount of damping is adjusted by altering the force clamping the two halves of the mass together.

The spring is a flat strip of steel and adjustment is provided for setting the zero position. Various ranges of acceleration can be measured with the instrument by changing the springs. In general, the instrument will measure a steady acceleration of $\pm\frac{1}{2}$ per cent of full scale with ranges of $-0{\cdot}3g$ to $+1g$, $\pm 8g$, $-3g$ to $+10g$ and $+0{\cdot}5g$ to $+1{\cdot}5g$. The range of damping extends up to critical for the highest range. The natural frequency depends, of course, on the range since the total movement of mass is

SOUTHERN RAILWAY CROSS-CHANNEL STEAMER "FALAISE"

FIRST-CLASS RESTAURANT STARTING PLATFORM

FIRST-CLASS LOUNGE, "B" DECK

BOILER-ROOM SHOWING FIRING PLATFORM

fixed at approximately 0·27in in each instrument.

The instrument shown is a prototype made at R.A.E. Drawings are now being made for a production version which will be slightly smaller in overall dimensions.

Statistical Accelerometer

The instrument is designed for the measurement of accelerations on a statistical basis in order that information on the stresses sustained during flight may be obtained. It consists of two parts, one the accelerometer proper and the other a set of electrical counters. The accelerometer consists of a number of similar units in which a hinged mass is held against a stop by means of a helical spring. If the mass moves from its stop by a small amount (0·005in) then an electrical contact is closed. When this occurs a corresponding electrical counter is energised and when the circuit is broken by the mass returning to its stop the counter counts one. Each accelerometer unit is adjusted so that the contact is closed when a particular value of acceleration is applied to the mass. Each counter therefore counts the number of times the predetermined acceleration has been exceeded.

Besides presenting the data in a convenient statistical form, this type of accelerometer is very useful for other applications where the accelerations to be measured are of a transient nature, since, as there is practically no movement of the recording mass, there is no question of damping or natural frequency influencing the response of the instrument. In fact, the response of the instrument is limited by the time required to pass sufficient current to energise the coil of the counter. This is about fifteen milliseconds. It is possible to improve this to two milliseconds by a modification whereby a high-speed relay is introduced between the accelerometer unit and the counter, which keeps the current supplied to the counter until the counter operates even though the accelerometer contact has already broken.

Southern Railway Cross-Channel Steamer "Falaise"

LAST week a party of special guests of the Southern Railway Company made the first voyage in the new cross-Channel steamer "Falaise," and were warmly welcomed at St. Malo and Dinard. The ship, which we illustrate herewith, is noteworthy as being the first post-war vessel of the company and she has been appropriately named after the ancient Normandy town Falaise, which figured so prominently in the victorious action which led eventually to the liberation of Europe. She was designed to be available for both day and night services, and to operate on any of the company's cross-Channel routes, which has restricted her dimensions.

On Monday, July 14th, she inaugurated the direct route service between Southampton and St. Malo. As it is not yet possible, owing to war damage, to berth at St. Malo, passengers are taken ashore in motor boats from Dinard Roads, where the "Falaise" anchors.

Like many other famous cross-Channel steamers of the Southern Railway, the "Falaise" was built and engined at the Dumbarton shipyard and engine works of William Denny and Brothers, Ltd., a firm which, we may recall, built the first cross-Channel steamer in 1814.

The principal dimensions and particulars of the new vessel and her propelling machinery are given in the following table:—

Hull Dimensions and Particulars:

Length overall	314ft
Breadth	48ft
Depth	17ft 6in
Draught	12ft 6in
Displacement	2720 tons
Gross tonnage	3710 tons
Designed service speed	20½ knots

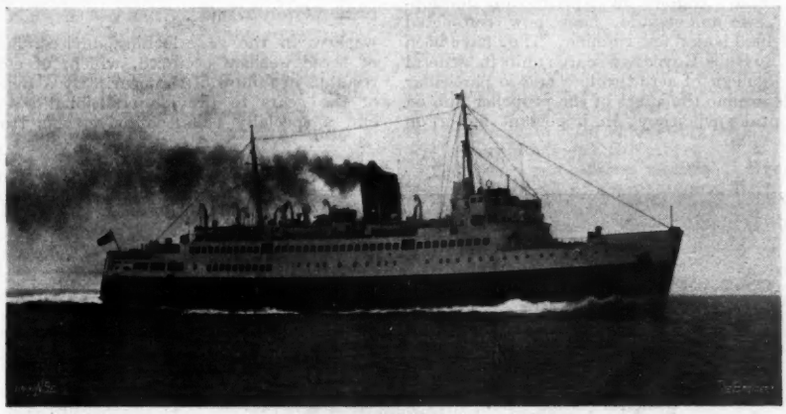
Passenger Accommodation:

Number of passengers carried	1400
Number of private cabins ...	133

Propelling Machinery:

Type	Parson's twin-screw single-reduction-geared turbine
Designed output	10,000 s.h.p.
Service output	9000 s.h.p.
Type of boilers	Foster-Wheeler twin oil-fired water-tube
Working steam pressure	450 lb per square inch
Superheated steam temperature	750 deg. Fah.
Generating surface per boiler ...	6950 square feet
Superheater surface per boiler ...	850 square feet

The pleasing appearance of the "Falaise" with her single funnel, two masts and superstructure will be noted from the accompanying engraving. In this new ship extra accommodation for passengers has been provided and there are large and spacious lounges, smoking rooms and restaurants, while in addition there are several buffets with serving counters for hot drinks and light refreshments. We illustrate on page 86 the first-class lounge and the first-class restaurant. The sleeping accommodation is greater than on any other vessel built for the Southampton routes, and there are 133 private cabins. A new feature is a shop which serves the first and third-class lounges. The ship is decorated throughout in a modern style and in the public rooms extensive use is made of plastic walls and wood veneered panels. In the upper deck lounges and smoking rooms, fluorescent lighting is employed, giving shadowless illumination. For day service, a special point is the large armoured plate glass windows, which give excellent views from the covered deck lounge, as may be seen from the accompanying engraving. Air conditioning has been applied on modern principles, and it is unnecessary for windows to be opened. For the cabin passengers, bathrooms and shower baths are provided. A radio telephone is available for passengers, so that if desired they may ring up their homes during the voyage.



S.S. "FALAISE"

Aids to Navigation

Use has been made of the latest aids to safe navigation including radar equipment, designed to enable the ship to be run safely even under foggy conditions. A direction-finder is also installed, a fathomer for depth-recording, and a Chernikieff log, so that the speed of the ship and the distance run can be recorded. In order to indicate and control any possible outbreak of fire in the holds, a smoke recorder in the wheelhouse is fitted. A bow rudder, which can be controlled from either wing of the bridge, enables the ship to be brought into harbour stern first. On the bridge are the usual navigating instruments and in front of the helmsman and at other steering positions, the revolution counter, steering indicator and steering compass are repeated.

Propelling Machinery

The propelling machinery of the "Falaise" comprises a twin-screw arrangement of Parson's single-reduction geared steam turbines, each driving a bronze propeller at 270 r.p.m., and taking steam from twin Foster-Wheeler oil-fired water-tube boilers. The turbines have a maximum designed output of 10,000 s.h.p., and under service conditions develop about 9000 s.h.p. Steam is supplied from the boilers at a pressure of 450 lb per square inch and a superheated steam temperature of 750 deg. Fah. For supplying the steam required for all hotel services a small vertical domestic oil-fired boiler is fitted. The two 200kW steam turbine-driven generating sets supplied by W. H. Allen, Sons and Co., Ltd., of Bedford, have a designed output some ten times that of the earlier cross-Channel ships, and they supply current for the ship's lighting and power to the deck auxiliary machinery, the engine room fans and the galley equipment. For furnishing power and light when in harbour, an Allen oil engine-driven generator set of 200kW output is installed.

The "Falaise" is the second cross-Channel steamer to be fitted with a Denny-Brown stabiliser. Great improvements have been made since the first vessel was so fitted, and the wide experience with naval craft during the war, which were fitted with stabilisers, has been incorporated in the new design installed. It is confidently expected that in bad weather the use of the stabiliser should enable the rolling of the ship to be reduced very considerably.

Trends in Reinforced Concrete.—The Reinforced Concrete Association proposes to hold a meeting next October, at which a symposium on "Trends in Reinforced Concrete" will be presented, and contributions are invited. The symposium will cover the whole field of reinforced concrete uses—design, construction, materials and plant—and each paper must therefore be limited in its length and scope. Opportunity will, however, be given later for the elaboration and fuller discussion of those which appear to be of particular interest or importance. In order to avoid duplication, those wishing to present a paper should submit a note of the subject with which they propose to deal, with a brief synopsis, so that a suitable selection may be made. The paper itself should not take more than ten minutes to read. Preliminary notes should reach the Association, 94–98, Petty France, London, S.W.1, not later than July 31st.

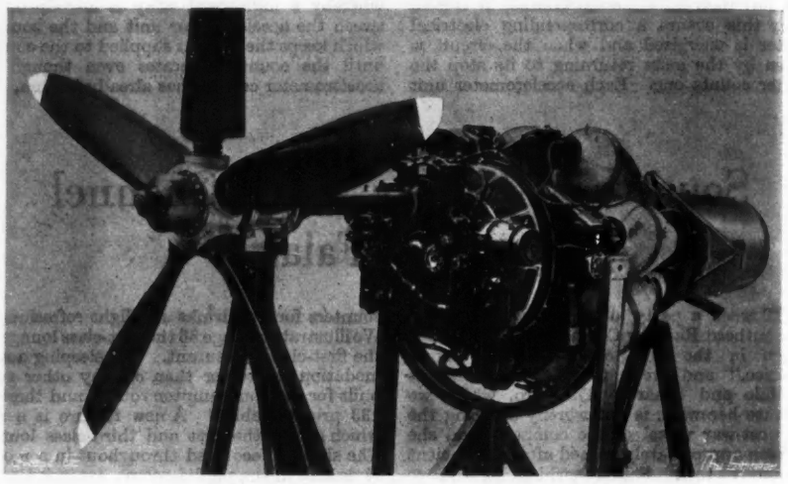
Rolls-Royce "Trent" Gas Turbine Propeller Engine

IT was foreseen by Rolls-Royce, Ltd., that in developing the gas turbine to drive a propeller, new problems would arise which would not be readily solved without considerable experiment. To await the production of an entirely new engine, designed from the outset to drive an airscrew before exploring the possibilities of the type, would have meant much delay, probably as much as two years, and a short cut to early development was to modify existing jet engines to drive propellers. Investigation by Rolls-Royce into propeller turbine possibilities dates back to the "Welland" engine, which was the first Rolls-Royce jet unit to be tested for shaft horsepower. These particular tests are of historic interest because so far as is known they were the first b.h.p. tests ever made of an aero-turbine.

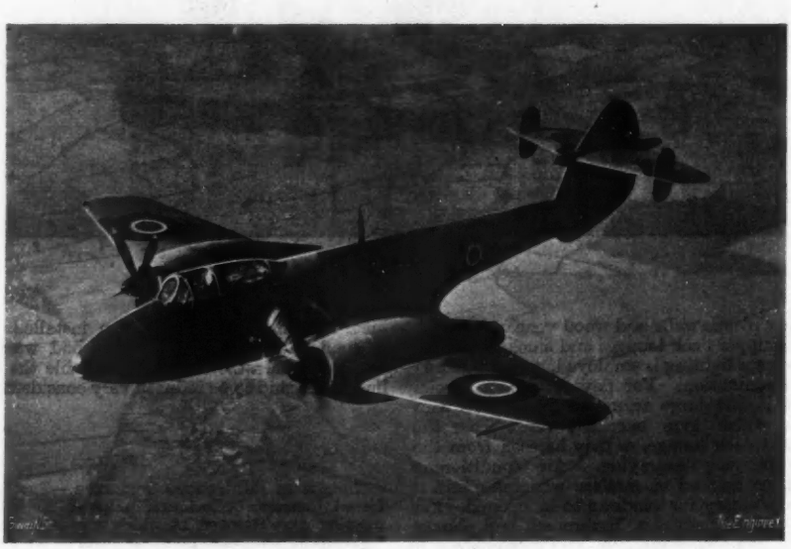
Further research included the modification of a "Derwent II," rated at 2200 lb thrust. This engine was refashioned to take a reduction gear and was named the "Trent." It was first tested in May, 1944, fitted with a reduction gear but no airscrew; in March, 1945, it was hangar-tested, complete with a five-bladed airscrew supplied by Rotol, Ltd. The first flight of an aircraft with an aero-turbine driving a propeller was made in September, 1945, when the Rolls-Royce "Trent-Meteor" took off. The "Trent-Meteor" has since done many hours of flight development and was publicly demonstrated at the International Air Rally, Derby, on June 21st, when the performance with one engine feathered was particularly impressive.

"Trent" engines on experimental development, we understand, have now completed over 1000 hours' test running. They have been used by Rolls-Royce as research units for general development of aero-turbines and in particular to determine the effect of the propeller hub on air intake efficiency, an important factor on gas turbine engines. Development of suitable reduction gears for aero-turbines has also been studied, with more than 400 hours of test-bed running.

The reduction gear of the "Trent" consists of three layshafts arranged to form a double train of gears, driven from the compressor and having a final simple reducing gear to the propeller. The overall ratio between the turbine and the propeller is 0·141. The gears used in the first designs were plain spur wheels, but due to the high contact speed of the teeth setting up resonant vibrations which coincided with the natural frequency of tab washers in the gear locking devices, fatigue of these washers occurred, which, of course, resulted in failure of the gear. By a redesign of the gears to provide additional strength and a specially balanced drive, this trouble has been overcome, and the gearing now used has been proved dependable by many hours of test-bed running.



"TRENT" TURBINE PROPELLER ENGINE



"TRENT-METEOR" RESEARCH AIRCRAFT

Application to the "Meteor"

For the flight trials of the "Trent" engines a "Meteor Mark I" aircraft was used. Modifications to the machine included a strengthened undercarriage and an increase in the throw of the undercarriage legs to give an additional 6in of ground clearance for the 7ft 7in Rotol propeller. These propellers absorbed 750 h.p., with a residual thrust from the engine of 1000 lb.

It was decided that the machine should be first flown with independent control of the throttle and constant speed unit, in order to find what degree of co-ordination between their movement was required and whether this could be left for the pilot or whether they should be linked together and worked simultaneously by a single lever. The flight trials proved that with completely independent controls the pilot required a great degree of skill to be able to fly at all. Unless the co-ordination was correct, very rapid changes in thrust were encountered, amounting in extreme cases to negative thrust, which severely upset the characteristics of the machine. As a result of its unsatisfactory flying qualities during the initial trials, the "Trent-Meteor" was grounded for a time.

When development was resumed it was decided as a temporary expedient to fit smaller diameter propellers, 4ft 10½in—which would absorb only 350 h.p. and by decreasing the jet pipe diameter raise the thrust to 1400 lb. Although this made the "Trent-Meteor" virtually a jet-propelled aircraft, it enabled flight development of the engine to continue and provided useful data for the single-lever control which is now used. With this scheme the constant speed unit is automatically reset to control at a lower speed when the turbine speed is reduced, and with its incorporation the excellent flying qualities of the "Meteor" have been entirely restored.

As a research engine the "Trent" has been invaluable to Rolls-Royce, and it will continue to be actively developed in this capacity, there being no intention to manufacture it as a production unit.

M.Sc. IN AGRICULTURAL ENGINEERING.—The Senate of the University of Durham has agreed to the institution of a two-year course at King's College, Newcastle-upon-Tyne, leading to the degree of Master of Science in Agricultural Engineering. In order to be admitted to the course, candidates must hold a bachelor's degree, of this or any other approved university, either in agriculture or in mechanical or electrical engineering. The subjects studied will differ according to the entrance qualification. The course for candidates who hold a degree in agriculture will begin in September, 1947, and for candidates who hold a degree in mechanical or electrical engineering in October, 1947. Applications for admission should be made to the Registrar, King's College, Newcastle-on-Tyne, 1.

Technical Knowledge and Engineering Progress*

EXPERIENCE has shown that there are several well-trodden paths of training and experience leading to success in the engineering profession; and also that no profession offers such opportunities for advancement to the highest positions in it, whether the entrants are with or without means, provided they possess the fundamental qualities of ability, integrity, imagination and perseverance. Success depends upon solid achievement. Errors and failure are not easily buried. Perhaps for this reason engineering, in demanding good, solid thought and work, is and has been the most democratic of the professions. Outstanding engineers have been produced at all levels of the social scale. For example, George Stephenson was of most humble origin, and, at the other extreme Parsons was of high birth. The degree of technical knowledge possessed by engineers has ranged almost as widely as their circumstances, and consequently it is of interest to consider the connection which has occurred between technical knowledge and engineering progress, and what its trends are to-day.

TECHNICAL AND PRACTICAL KNOWLEDGE

The position has possibly been obscured at times by the fact that engineering involves a combination of technical enquiry and interpretation joined with practical development, and in many cases practical development by apparently cut-and-try methods, with subsequent adjustment in the light of experience, including partial success and failure, has bulked large. Also, in the past, but not the present times because of the overwhelming evidence of the vital part played by scientific and technical knowledge, a disparaging attitude against technical knowledge beyond a rudimentary order has sometimes been exhibited by ultra-practical men. An extreme case was a remark made to me when a young man by a manager of a large engineering works in reference to apprentices who attended evening classes that "generally he had very little use for $a+b$ fellows" (but he used a stronger designation of common currency). Doubtless his attitude was largely due to the fact that he had been able to get along very well upon very little technical knowledge, and perhaps he affected to scorn the things he did not possess, aided maybe by a small basis of justification in that the exhausting ordeal of attending evening classes after a full day's work left little energy and life in his trade apprentices for the next day's work. While this was a wasteful way, and rather like Nature's way, of producing a few engineers of sterling capacity and worth, who, coupled with the qualities we have mentioned, were blessed with hardy constitutions, it had indeed an accompaniment of disappointment to many of the individuals concerned, and also probably to some works' authorities. Nevertheless, where the method was successful the arduous conditions undoubtedly brought out and developed the qualities of tenacity and capacity for hard work to a degree which, under easier courses, might not have matured.

QUALITY AND QUANTITY

Before passing to consider evidence of the relationship between technical knowledge and engineering progress, I am prompted, in connection with our reference to the small yield of very able men who have come to the top against hard conditions, to remark upon quality, especially as it is now projected to increase considerably the numbers of our technically trained young men. While there is need for greater numbers, the more urgent need in the long run is for the comparatively few outstanding men. As with the early pioneers, in which our country has been so fortunate, so to-day progress and new development springs mainly from a comparatively few gifted men of vision, ability, originality and drive; and no effort should be spared to discover and cultivate them, or perhaps it may be more correct to say to provide the best conditions for them to discover themselves. The immediate need is for production, and rightly so, but in the long run production will fail the nation unless it is coupled with technical superiority.

TECHNICAL ABILITY AND PROGRESS

The ability of engineers and technicians to make calculations relating to the design and performance of all kinds of machines and structures has increasingly become a feature of engineering progress and development. Indeed, ability to calculate has proceeded so far that it can and may delay progress. Our ability to make calculations may result in postponement of development. A time comes when a decision has to be made to make something. In later years our continental competitors, who are also good calculators, have shown alacrity in getting something made. While the most critical and informative technical investigation of a new project should be made before entering upon the development of an actual equipment, I think, as a nation—speaking generally, we have some lee-way to make up. We should all be on our toes to get quickly off the mark when speculation or enquiry suggests that some new development or useful improvement is indicated. There is little doubt that our continental rivals have found early development highly profitable in the invisible export of ideas in the shape of licence arrangements and the accruing patent royalties, in addition to the direct benefit to their own industries. An outstanding example of where our own country must have similarly benefited from a comparatively rapid new development was the conversion of the steam turbine by Parsons from an interesting device to the most important of large power prime movers. Parsons made calculations and had calculations made. As a matter of interest, I was informed that, in the very early days of Parsons' work, he consulted Osborne Reynolds, who was an authority on fluid mechanics. But he lost no time in pushing on with construction and expensive development with great profit and credit to this country.

With the rise of the steam turbine for ship propulsion, continental engineers concentrated attention upon the high-compression oil engine of Diesel, and now, except for very large powers, this engine has achieved a leading position in marine propulsion. There was a time when this country was building more oil engines for ships than any other, and yet the bulk was under licence to continental engineering firms. Continental engineers, being first in the field to pursue development, have profited their countries just as this country has been benefited by its priority with the steam turbine.

It is clearly important, from these examples, that our engineers and technicians should be reaching out all the time for new developments. The basic principle of a new development may sometimes result from a discovery in science, but often it is not so fundamental and it derives from new knowledge, or an improvement in one field altering the balance in another. Often in all these, however, there is a considerable interval between the arrival of knowledge or of conditions which render an advance possible, and the utilisation of this knowledge. It is here that foresight, imagination and a deliberate policy of keeping abreast with new knowledge can help in minimising the interval preceding its application.

* Extracts from a lecture by Dr. R. W. Bailey in connection with Jubilee Celebrations of Leicester College of Art and Technology, July, 1947.

The Air Registration Board

ON Thursday of last week, July 17th, the Air Registration Board held a luncheon at the Savoy Hotel, Strand, W.C.2, at which the chairman, Lord Brabazon, presented the annual report. The Minister of Civil Aviation, Lord Nathan, was amongst the guests.

It may be recalled that the Air Registration Board was constituted in 1937 as a result of the recommendations of the Gorell Committee of 1933, which recommended that technical matters connected with civil aircraft should be delegated to a board representing the principal interests in aviation. The Gorell Committee itself was appointed as a result of the feeling prevalent that the control of airworthiness of of civil aircraft should be removed from the influence of the Service side of aviation. Many of those interested in civil aviation realised that the experience gained in the classification and survey of ships might be applied, with suitable modification, to the control of civil aircraft.

The Air Registration Board normally recommends to the Minister of Civil Aviation in connection with some matters; in others it has direct authority. The principal matters which are of concern to the Board are:

The examination of design and the survey of construction with a view to recommending the issue of certificates of airworthiness for "prototype" and "series" aircraft.

Survey of civil aircraft submitted for the renewal of certificates of airworthiness with a view to recommending the renewal or extension of the certificate.

Approval and certification of constructors of civil aircraft and manufacturers of components and materials as persons from whom the Board, on behalf of the Minister of Civil Aviation, may accept reports.

Examination of persons employed on the inspection of aircraft and any other duties performed by licensed engineers with a view to recommending to the Minister of Civil Aviation the issue of the licences required by the Air Navigation Order.

The publication of technical information and requirements necessary to the performance of these functions, and the advising of the Minister of Civil Aviation on the technical aspects of all matters delegated to the Board.

Under its constitution, the Board, in addition to these delegated duties, is also able to report on aircraft for the information of insurers and others.

Although the activities of the Board naturally decreased during the late war, its home organisation enabled it to deal with any civil aircraft in the British Isles, and it maintained offices abroad wherever the operations of British aviation required them. With the redevelopment of civil aviation, it is continuing its pre-war policy of extending its activities throughout the British Empire, either by direct representation or by arrangements with Dominion Governments, in order to facilitate the survey of British aircraft in any part of the world.

The Board publishes a register of civil aircraft in the form of a card index. Each card gives full particulars of one aircraft and the register is kept up to date by the issue of weekly supplements.

At the luncheon referred to above, in introducing the annual report, Lord Brabazon said that no nation had already included and implemented so many I.C.A.O. (Internation Civil Aviation Organisation) recommendations as we had. The Board's register of civil aircraft now contains details of 1238 aircraft, an increase of 758 during the year.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

FISH BOLTS AND NUTS

No. 64 : 1946. A revision of B.S. 64 for steel fish bolts and nuts for railway rails has recently been issued. The following are the principal features in the revision:—

(a) *Quality of Steel.*—The mechanical properties of the steel from which the bolts and nuts are made are specified separately. Provision has also been made for tests on the finished bolts, due regard being taken of the work hardening during manufacture.

(b) *Unscrewing Test.*—The conditions of carrying out the unscrewing test on bolts up to $\frac{3}{4}$in have been specified separately to those for bolts over $\frac{3}{4}$in. The weights to be supported have also been adjusted.

(c) *Screw Threads.*—The Whitworth screw thread dimensions have been revised so as to be in accord with B.S. 84 : 1940.

(d) *Range of Sizes.*—The dimensions of the bolts for use with bull-head rails (70 lb to 100 lb) and flat-bottom rails are now included.

(e) *Weights.*—The weights for bolts and nuts are included. Price 2s.

Industrial and Labour Notes

British Overseas Trade

The value of exports of United Kingdom goods increased in the month of June to £93,132,725, the highest monthly figure to be recorded since the end of the war. In volume, June exports were equal to 107 per cent of the 1938 average, compared with 104 per cent in May. The value of imports also showed a further increase in June and at £153,844,385 was higher than in any month since July, 1920. Re-exports of imported merchandise dropped to £4,130,062.

The Board of Trade, in commenting on these figures, which were issued on Monday last, says that whilst the effects of the fuel crisis are largely past, the value of exports is not as high as it would have been if production had not been disturbed so seriously in February. The month of June contained only twenty-four working days, and the figures therefore indicate a sharp increase in the rate of exports, compared with earlier months of this year.

Exports of vehicles reached, in value, a new record in June and at £14,396,089 accounted for roughly one-third of the increase in the month's total export value. The number of new cars exported, 10,302, was, however, 368 below the May figure. Machinery exports in June amounted in value to £14,232,631, an increase over the figures recorded for the two preceding months. In quantity, machinery exports in June totalled 57,475 tons, compared with the monthly average of 38,272 tons in 1938.

Unofficial Strikes

Before the conference of the Transport and General Workers' Union was concluded at Hastings last week, a resolution was passed urging the executive to examine unofficial strikes with a view to their elimination. The resolution, which it is reported was passed almost unanimously, expressed the deep concern of the conference over the recurrence of unofficial strikes, and pointed out that, while at times there might be a feeling of frustration, every member had a constitutional obligation to observe the rules of the union. The resolution emphasised that the only body authorised to sanction strike action was the general executive council of the union.

Another resolution passed by the conference expressed the opinion that the machinery of industrial negotiation, conciliation and arbitration should be reviewed to ensure that industrial matters could be dealt with expeditiously.

Employment and Unemployment

The latest figures issued by the Ministry of Labour regarding employment in Great Britain show that in the month of May the total working population was 20,170,000, a figure 40,000 below that recorded for April. At the end of May, however, the total working population was greater than at mid-1939 by 420,000 (236,000 less men and 656,000 more women). The number of people employed in industry in May was 18,298,000 (12,702,000 men and 5,596,000 women), compared with 18,249,000 in April and 17,920,000 at mid-1939.

A closer analysis of the Ministry's figures indicates that 5,548,000 people were engaged in May on manufacturing for the home market and 1,489,000 for the export market. The "home market" figure, which includes those engaged in manufacturing equipment and supplies for the forces, was slighty below the comparable April figure, and consequently an increase was shown in the number employed in manufacturing for export in the month of May. In the non-manufacturing industries and services employment increased during May to 11,261,000, compared with 11,215,000 in April.

Unemployment figures recently published by the Ministry of Labour relate to June 16th, on which day there were 272,336 insured persons on the registers, compared with 331,543 on May 12th. The June total included 196,928 men between the ages of eighteen and sixty-four. It included also 36,317 married women, many of whom have probably left industry, and 12,035 ex-service personnel who had not taken up any employment since demobilisation. There were, in addition, on June 16th, 11,704 uninsured persons including 1870 boys and girls under sixteen, who had not entered industry.

Coal Output

The Ministry of Fuel and Power issued its monthly statistics on coal production and consumption on Thursday of last week, the day on which coal was once again debated in the House of Commons.

The Ministry's figures relate mainly to the month of June, and they show that the average weekly output of mined coal was 3,623,900 tons and of opencast coal 227,400 tons. The comparable figures for the month of May were 3,516,800 tons and 198,900 tons, respectively. There was a drop in the amount of mined coal lost in June, the weekly average being 132,900 tons, of which recognised holidays accounted for 66,000 tons, disputes for 38,300 tons, accidents, breakdowns and repairs to machinery, for 25,000 tons, and other causes for 3600 tons.

The number of wage-earners on colliery books averaged 717,500 a week in June, those effectively employed averaging 659,600 a week. Absenteeism—both voluntary and involuntary—increased slightly and is calculated to have been 11·94 per cent, compared with 10·40 per cent for that part of May in which a five-day week was worked. The shifts worked by face-workers averaged 4·36 a week in June, the output per manshift worked at the face being 2·87 tons.

The total inland consumption of coal during June averaged 3,274,000 tons a week, and overseas shipments and bunkers took up another 104,000 tons, giving a total weekly consumption of 3,378,000 tons, compared with 3,489,000 tons a week in May and 3,447,000 tons in June, 1946. The total distributed coal stocks at July 5th were 10,522,100 tons, compared with 8,603,300 tons on July 6, 1946.

Speaking at Morpeth, last week-end, Mr. Arthur Horner, secretary of the National Union of Mineworkers, said that with present trends, the country would be at least 5,000,000 tons short of its coal requirements by the end of this year. The coal-mining industry, he added, needed more men and if the situation was to be saved there must be sacrifices in the use of more manpower at one point or another. On the other hand, unofficial strikes which caused a loss of half a million tons of coal in the first six months of this year, should not be repeated. Mr. Horner said also that absenteeism had gone back to three-quarters of what it was prior to the five-day week.

Transport and the Economic Situation

Speaking at a Press conference on Britain's economic situation, on Wednesday of last week, the Lord President of the Council, Mr. Herbert Morrison, gave a warning that the country might be faced with a serious problem over goods wagons during the winter, as goods traffic measured in ton-miles was to-day higher than before the war, but the number of wagons was approximately the same. Before the war, Mr. Morrison said, about 3 per cent of the wagons were under repair at any given time, but now the figure was over 12 per cent, and the difference of 9 per cent meant that 150,000 of the total of 1,250,000 wagons were lost for working purposes at any given time. Mr. Morrison thought that if we were spared an abnormally severe winter, and if some improvement could be made in the speed of turn-round of trucks, then the railways would be in a position to move coal supplies as necessary, but there would be some shortage of wagons for other purposes. This shortage might be of the order of about 10 per cent, but it could, of course, be worse in particular districts at particular times.

Mr. Morrison went on to say that the commodities likely to suffer owing to a lack of transport were heavy goods like bricks, cement, iron ore and steel, and there was, consequently, a risk of a certain measure of slowing down in basic industrial activity, and in building, during the winter months. Wagon production was now recovering from the effects of the fuel crisis, Mr. Morrison stated, but more wagons must be manufactured. The rate of turn-round was another matter which called for consideration and whilst it would not be easy to effect a substantial improvement, the Ministry of Transport was examining various measures for so doing. There was also the task of increasing the rate of repair. At present this was about 100,000 wagons a week—double the pre-war figure—and any further improvement was a matter of plant, labour and materials. The railway companies had opened new depots in Scotland and the North of England and were examining the question of using various plants in South Wales for repair purposes. The timber position was improving a little, but shortage of steel plate was still a major difficulty.

Education in Industry

In the course of his Presidential Address to the Engineering Industries' Association at the recent annual meeting in London, Viscount Davidson said that it was important that the leaders of industry, the employers and trade unions, should study together the fundamental problems which no Government, no Parliament and no party politicians could solve. There had been, he pointed out, an extension in technical education, and every day one read of appeals to improve it. Furthermore, the application of scientific knowledge to industry had increased by leaps and bounds.

For years, Lord Davidson continued, in their perfectly legitimate endeavour to improve the lot of the workers, the unions had been instilling into their members a desire for better wages and conditions. Human nature being what it was, and education in the national and technical schools becoming more modern and material, the worker's outlook, he suggested, had become out of balance, and the tendency was to think in terms of "what I can get" rather than of "what I can give." Education in the facts of industry was vital, Lord Davidson asserted, and a national campaign might well be organised by all the employers, managers and operatives in industry to regain the moral standards which once made us the most contented and prosperous people in the world.

The Technical and Scientific Register

The Ministry of Labour has recently circulated a pamphlet which explains the scope and functions of that branch of its Appointments Department known as the Technical and Scientific Register. The Register is divided into sections according to the nature of various professions, and is available for assisting persons with certain technical and scientific qualifications to find suitable employment. It is confined to physicists, mathematicians, chemists (other than pharmacists), metallurgists, biological scientists, civil, mechanical and electrical engineers, architects, surveyors, town planners, estate agents and valuers, and, in general, the qualification for registration is the possession of a university degree or membership of an appropriate recognised professional institution.

The Register is maintained in two main groups, namely, those not at present in employment and those in employment but available for and seeking alternative employment. It is not therefore solely a placing agency for those seeking employment, as it provides a free advisory service, helping both those who are unemployed and anxious to get settled into a job and those who desire a change of employment for one reason or another.

French Engineering News

(From our French Correspondent)

PARIS, July 18th.

The Paris Metropolitan railway is now engaged on extending the suburban line from Gare St. Lazare to Porte de St. Ouen and Carrefour Pleyel, at St. Denis. This work will involve the construction of three stations, each 75 metres long. Altogether, the length of line is a total of 3 kilometres, with stations at intervals of 989 metres, 804 metres, and 947 metres. Some 2299 metres of double track will have to be constructed, and 286 metres of treble track for carriage sheds. The line will be linked to the maintenance shop by 97 metres of track constructed above ground. Three entrances will be available at two of the stations and six at the terminus. By May 1, 1947, 80 per cent of the work had been completed. Rolling stock on this line will comprise new, articulated units which can be uncoupled and adapted according to the number of carriages required for traffic involved. Daily electricity consumption for the whole line will be about 62,000kWh. Traffic on the line, which is expected to be very heavy, will later be reduced by the creation of a new line crossing Paris from North to South—the Maire d'Ivry-Carrefour Pleyel line. This is part of a big plan to reorganise existing urban lines.

* * *

Steel production is expected to show a decrease following the miners' strike which has just ended. This will mean a reduction in allocations of ferrous metal to industry, which has already been worked out for the third quarter. It is envisaged that the reduction will amount to perhaps 10 per cent.

Utilisers of high-speed steel are asked to note that much difficulty is experienced in obtaining the necessary quantities of tungsten ore. The shortage is expected to last some years, and meanwhile it will be impossible to supply the amount of ferro-tungsten required by steelworks. It is therefore urged that steel composed of 18 per cent tungsten should only be used in the few cases where other steels are not suitable. Although production has increased considerably over recent years, tungsten is still scarce.

* * *

Morocco is at present exploiting the Atlas waters and Djerada coal to obtain electric power. Equipment used comprises hydraulic installations giving a total of 61,900kW and thermal plant supplying 35,280kW. Demand has risen continually from 11 million kW in 1923 to 245 million kW in 1946, and for some years demand has exceeded supply. A large programme of new installations has therefore been undertaken, which will give a further 155,000kW hydraulically produced and 71,260kW produced by thermal plant. Consumption is expected to reach 800 million kW in 1953.

* * *

A big programme of industrial and economic development is being carried out in Morocco. A Société des Charbonnages Nord-Africains has been created to organise coal supplies. There is also a project involving the underground gasification of anthracite at a depth of 15m, in order to supply proposed electric plant. A Société d'Etudes Sidérurgiques has been formed and is engaged on research on the reduction of Moroccan iron ore, with a view to utilising Moroccan fuel. Ore production in 1938 amounted to over 450,000 tons. Steel production was greatly improved in 1947 by the addition of a 4-ton, 1600kVA Stein-Roubaix electric oven. Five companies are participating in the extraction of lead ore in Morocco, of which 2710 tons were produced in 1945. It is hoped that zinc production will be quadrupled in a few years. Since phosphates remain the main mineral resource of the country, a manure plant is to be added to the Casablanca superphosphate factory. Important copper deposits have also been found, and it is thought that manganese mines may bring Morocco into the front rank of world producers of this ore.

Notes and Memoranda

Rail and Road

RAILWAY WAGONS.—The Minister of Supply stated in Parliament recently that railway mineral wagons were now being produced at the Royal Ordnance Factories at Dalmuir, Patricroft and Woolwich, to the full extent that the supply of components allowed.

RAILWAY ELECTRIFICATION IN SWEDEN.—Electrification has now been completed on the section of line between Vasteras and Frovi in Central Sweden. With the electrification of this line it is now possible to travel by electric train from Stockholm via Västeras, Köping and Arboga to the industrial town of Orebro, in the heart of the Central Swedish mining district, and this summer to be the site of a big industrial and cultural exhibition. The travelling time from Orebro to Stockholm has been shortened by about one hour. The new electrified section was one of the first railway lines built in Sweden about ninety years ago. Of the total Swedish railway net of 16,570km (10,275 miles), 5837km (3620 miles) are at present electrified, and of these lines 4809km (2982 miles) belong to the State Railways.

TRANSPORT BILL WARNING.—The British Engineers' Association has issued a caution to its members that there is reason to believe that some road hauliers whose undertakings are likely to be acquired by the British Transport Commission when the Transport Bill becomes law, may in anticipation desire to dispose of their road vehicles to manufacturers and traders who would be able to operate them under "C" licences. The attention of members who may be contemplating the purchase of such vehicles has been drawn to Clause 46 of the Transport Bill, which, if enacted, will give to the Transport Commission power in certain circumstances to repudiate such transactions with the consequent possibility that the purchaser would lose the vehicles and probably experience difficulty in recovering the purchase money. It has been suggested that such members should not only give careful consideration to the above Clause, but also keep in mind the wider consideration that any considerable increase in the number of vehicles operating under "C" licences may lead to protective action being taken by the Minister of Transport in pursuance of the warning given when he agreed to remove "C" licences from the operation of the Bill.

Air and Water

SEVERN BARRAGE SCHEME.—Replying to a question in the House of Commons a few days ago, the Parliamentary Secretary to the Ministry of Fuel and Power said that the construction of and experiments with a tidal model, which were an essential preliminary to further consideration of the Severn Barrage Scheme, would take two years. In the meantime, no final conclusions could be reached.

FIRST FLIGHT OF AIRSPEED "AMBASSADOR."—The prototype Airspeed "Ambassador," a new twin-engined pressurised aircraft with accommodation for up to forty-eight passengers, took off from Christchurch aerodrome on its first flight recently. The "Ambassador" is designed to carry forty passengers and luggage, a total payload of 8400 lb, at 255 m.p.h., at 12,500ft for more than 1000 miles. Bristol "Centaurus" radial power plants, each of 2600 b.h.p., are fitted. The aircraft has thermal anti-icing equipment, a steerable tricycle undercarriage with duplex wheels and braking airscrews.

B.O.A.C. TRANS-SAHARA ROUTE.—The first commercial air trunk service into Ceylon from the West was opened by British Overseas Airways Corporation on July 14th. It is operated with Handley Page Halton aircraft once weekly in each direction between London and Colombo, *vid* Castel Benito, Cairo, Basra and Karachi. Departure days are Mondays from the United Kingdom and Saturdays from Ceylon. A special feature of the service, equipped to carry ten seated passengers, is that freight space available on each flight for samples or goods is nearly one ton. The schedule allows for a 24-hour stay in Cairo on the outward journey and a stop of nearly 12 daytime hours there on the inward journey. Plans have been made to transfer the B.O.A.C. Speedbird United Kingdom-West Africa service from the coastal journey to the direct trans-Sahara route in the autumn. Proving flights, using Halton aircraft, will be carried out shortly and the route will be *vid* Kano to Lagos.

Miscellanea

RESEARCH AND THE SMALLER FIRM.—In October, 1946, the Manchester Joint Research Council held a conference on the subject of "Research and the Smaller Firm." A full account of the proceedings, with the text of the papers presented, has now been published and may be obtained from the Council at Ship Canal House, King Street, Manchester, price 2s. 10d., including postage. The Council is now planning another conference to be held next October, when the subject will be "Market Research."

ACCOMMODATION FOR THE ELECTRICITY BOARDS.—One of the matters that is claiming the attention of the Organising Committee for the Electricity Supply Industry under the chairmanship of Lord Citrine, is the accommodation that will be required by the Electricity Boards for their headquarters, technical, administrative and accounting staff. To assist the committee in obtaining the relevant information the Electricity Commissioners have addressed a circular letter to all authorised undertakers, asking them to complete a return showing certain details of the accommodation at present held and occupied.

WIRE ROPES.—The Minister of Supply was asked in the House of Commons recently if he was aware of the acute shortage of wire ropes, particularly of those required for colliery use. In his reply, the Minister said that wire rope production was 20 per cent more than in 1938, but was still insufficient to meet the greatly increased demands. Expansion of production was dependent on increased supplies of steel, especially of imported, semi-finished material, and every effort was being made to improve the position. The Minister added that special priority was being given to the needs of collieries.

INVENTIONS COMPETITION.—The Association of Supervising Electrical Engineers recently announced the inauguration of a competition associated with an award donated by Dr. A. P. Thurston. A cash prize of £10 will be awarded annually to the electrical invention submitted and judged under the rules of the competition, to be the most valuable contribution to the advancement of either (*a*) utilisation of electricity; (*b*) the improvement of distribution technique, or (*c*) installation technique. The competition is confined to membership of the Association and particulars can be obtained from the General Secretary, A.S.E.E., 54, Station Road, New Barnet, Herts.

LICENCES FOR PIG IRON AND SCRAP.—The Iron and Steel Board wishes it to be known that in view of the necessity to make the most efficient use of available supplies needed for the production of iron castings, applications for licences for the purchase of pig iron and scrap are closely examined and the Board may be compelled to withhold such licence in the case of iron foundries not already in operation unless prior approval of the undertaking has been obtained. Individuals or companies contemplating entering the iron foundry business are accordingly advised to communicate with the Secretary of the Iron and Steel Board, Bush House, South-West Wing, Strand, London, W.C.2.

COAL-MINING IN CHINA.—The Chinese National Resources Commission says that in north-east China, of the ten major coal mines left by the Japanese, collieries already taken over include those at Fushun, Penchi, Hsian, Peipiao and Fushin. Installations at these mines have been partly dismantled since the end of the war, causing a great reduction in their production as compared with earlier days. The coal mines of Fushun, for instance, originally produced over 10,000,000 tons of bituminous coal yearly. At present, the daily output is no more than 6000 tons, roughly corresponding to the production at Fushin, where only 15,000 workers are employed, as compared with 45,000 at Fushun.

L.C.C. SEWAGE PURIFICATION WORKS.—At the last meeting of the London County Council, the Housing Committee reported on measures proposed for the purification of the sewage effluent discharged into the Thames from the main drainage outfalls at Barking and Crossness. An estimated expenditure of £2,725,000 is envisaged during the period 1947–57, although no substantial new capital expenditure will be incurred before 1949–50. The Council approved an estimate of £26,000 for preliminary expenses in connection with works to be carried out in the first five-year period at the Northern Outfall at Barking, where the need for improvement of the effluent is more urgent than at the Southern Outfall at Crossness.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Engineering and Marine Exhibition

Thursday, August 28th, to Saturday, September 13th.—London, Olympia.

Institution of Electrical Engineers

Saturday, July 26th.—N. MIDLAND STUDENTS: Summer Outing. 9 a.m.

Institution of Naval Architects

Tuesday, September 23rd, to Friday, September 26th.—Autumn meetings at Portsmouth and Southampton.

Public Works Congress and Exhibition

Monday, July 21st, to Saturday, July 26th.—London, Olympia.

Catalogues

RUSTON AND HORNSBY, Ltd., Lincoln.—Souvenir book for the Royal Show, Lincoln.

ALFRED HERBERT, Ltd., Coventry.—Catalogue of plain and screw plug gauges.

HELLIWELL AND CO., Ltd., 68, Victoria Street, S.W.1.—Folder on fabricated welding.

SPEED TOOLS, Ltd., 35–36, Percy Street, W.1.—Leaflet on the "Speetog" vertical clamps.

TUFNOL, Ltd., Perry Barr, Birmingham, 22B.—Booklet describing "Tufnol" gears.

BAKELITE, Ltd., 18, Grosvenor Gardens, S.W.1.—Illustrated booklet on bakelite progress.

WELLINGTON TUBE WORKS, Ltd., Great Bridge, Staffs.—Folder describing the "Weldex" heaters.

DAVEY, PAXMAN AND CO., Ltd., Standard Ironworks, Colchester.—Publications dealing with diesel engines.

ILFORD, Ltd., Ilford, London.—Publication dealing with X-ray films and screens for industrial radiography.

W. CHRISTIE AND GREY, Ltd., 4, Lloyd's Avenue, E.C.3.—Catalogues on the isolation of vibration and noise.

BLAW-KNOX, Ltd., Clifton House, Euston Road, N.W.1.—Leaflet describing the sheepsfoot tamping roller.

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Huddersfield.—Illustrated catalogue on spiral bevel units.

MCKECHNIE BROTHERS, Ltd., Rotton Park Street, Birmingham, 16.—Illustrated catalogue of extruded metals.

PROTOLITE, Ltd., Central House, Upper Woburn Place, W.C.1.—Booklet on "Prolite-Nurake" milling cutters.

HADFIELDS, Ltd., East Hecla Works, Sheffield.—Illustrated catalogue on sectional and solid steel jaw breakers.

MUREX, Ltd., Rainham, Essex.—Booklets and leaflets dealing with the firm's ferro-alloys, metals and fine chemicals.

ANDRE RUBBER COMPANY, Ltd., Kingston By-pass, Surbiton, Surrey.—Publication, entitled "Developments in Rubber."

CANTIE SWITCHES, Ltd., Northgate Works, Chester.—Catalogue No. CC1, entitled "Metalclad Switch and Fuse Gear."

LANCASHIRE DYNAMO AND CRYPTO, Ltd., Trafford Park, Manchester.—Catalogue of electrical equipment for gasworks.

DAVID BROWN FOUNDRIES COMPANY, Penistone, near Sheffield.—Illustrated catalogue of alloy and carbon steel castings.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., 42, Hertford Street, W.1.—Booklet on copper tubes for domestic water services.

LEA RECORDER COMPANY, Ltd., Parliament Mansions, Victoria Street, S.W.1.—Booklet describing the Romer-Lea coal meters.

BRETT'S PATENT LIFTER COMPANY, Ltd., Foleshill Works, Coventry.—Illustrated catalogue on drop-forging equipment.

DAVID BROWN TRACTORS, Ltd., Meltham, near Huddersfield.—Publication, entitled "Aids to Crop-master Farming."

JOHN HARPER (MEEHANITE), Ltd., Albion Works, Willenhall, Staffs.—Booklet, entitled "Harper-Meehanite Die Material."

GILBERT GILKES AND GORDON, Ltd., Kendal, Westmorland.—Illustrated booklet, entitled "On the Development of Water Power."

EUMUCO (ENGLAND), Ltd., Beverley Works, Barnes, S.W.13.—Catalogue dealing with the "Eumuco" coining and sizing press.

MUREX WELDING PROCESSES, Ltd., Hertford Road, Waltham Cross, Herts.—Catalogue describing "Tubex" hard-facing welding rods.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd., 51, Hatton Garden, E.C.1.—Illustrated catalogue of overhead line materials.

Personal and Business

MR. B. B. WINTER has been appointed a director of Rootes Securities, Ltd.

DR. F. LLEWELLYN SMITH has been appointed a director of Rolls-Royce, Ltd.

MR. H. W. PASTEUR and Mr. A. Greenfield have been appointed directors of J. and E. Hall, Ltd.

AIR COMMODORE J. SOWREY has been elected President of the Institution of Engineering Inspection.

MR. GEORGE WATSON, M.Inst.C.E., informs us that his address is now 20, Spencer Road, South Croydon, Surrey (telephone, Croydon 1051).

MR. R. F. NORRIS, formerly sales manager, oil engine division, of John Fowler and Co. (Leeds), Ltd., has now joined the sales staff of Associated British Oil Engines, Ltd.

MR. R. W. LORD has been appointed manager of Henley's (South Africa) Telegraph Works Company, Ltd., in succession to Mr. F. J. Head, who has retired after forty-two years' service with the company.

MR. LESLIE GAMAGE, joint managing director of the General Electric Company, Ltd., has been re-elected chairman of the British Export Trade Research Organisation. Mr. John Ryan, of Metal Box Company, Ltd., has been elected deputy chairman.

DAVY AND UNITED ENGINEERING COMPANY, LTD., announces that Mr. A. Poole, M.I.Mech.E., having passed the retiring age, has resigned from the position of chief engineer but is remaining with the company as whole-time consulting engineer. Other appointments announced by the company are: Mr. W. W. Franklin, A.M.I.Mech.E., chief engineer; Mr. W. Craig, A.M.I.Mech.E., assistant chief engineer-in-charge of sectional rolling mill design; Mr. W. H. Goodlad, assistant chief engineer-in-charge of flat rolling mill design; Mr. J. G. Frith, A.M.I.Mech.E., assistant chief engineer-in-charge of hydraulic machinery design; and Mr. R. Ballantyne, A.M.I.Mech.E., drawing office manager.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of Report.	Title.	Post free. s.	d.
EVALUATION REPORTS (Post free 3d.).			
C.I.O.S.:			
E/R 281 ...	Report on Insecticide Manufacturers in Hamburg		
E/R 312 ...	Deutsche Gold and Silver Scheidenstalt Hiagwerk: Wood Distillation		
E/R 323 ...	Interrogation of Gen. Dir. K. Frydag and Prof. Dr. E. Heinkel: Some Aspects of German Aircraft Production During the War		
E/R 324 ...	Klockner Humbolt and Deutz: Interview with Dr. Adolph Schnurle: Two-Stroke Diesel Engine		
E/R 343 ...	Report on Treibacher Chemical Works A.G.: Salts of "Rare Earth" Metals		
E/R 366 ...	Coal Carbonisation Research of Carl Otto and Co., G.m.b.H.		
B.I.O.S.:			
E/R 20 ...	Maas, Albrecht: Shells, Panzerfaust, Rockets, Gases		
E/R 178 ...	Telefonbau und Normalzeit: Electric Tachometer		
E/R 409 ...	Bochumer Verein A.G.: Wheels and Axles for Locomotives		
E/R 509 ...	Ed. Doerrenberg Sohne: Metallurgy and Metallurgical Plant		
B.I.O.S.:			
76	Pulp and Paper Industry in the Leipzig Area	2	1
423 (Appendix)	Cyanide Research and Production at Degussa: Interrogation of Dr. Baerwind	0	7
530	Photosurfaces: A Report on German Developments of Photo Cells, Electron Multipliers, Television Pick-up Tubes...	6	2
590	Deutsche Vacuum Oel A.G.: Information on Recording Pressure Gauges Used in German Oil Industry and the Testing of Mud, Measuring the Permeability and Porosity of Formation Cores, &c.	0	7
999	Manufacture and Fabrication of Polyvinyl Chloride: Bitterfeld Area	9	3
B.I.O.S.			
1102	40,000 Tons Forging Press and other Hydraulic Plant	1	7
1136	Technical Survey of Electric Cable Industry in Germany ...	5	6
1159	The Uses of Zinc in Germany: Includes Statistics on Import, Export and Production of Non-Ferrous Metals	22	6
1164	Fur Skin Dressing and Dyeing in Germany	4	6
1167	German Railway Maintenance Methods Covering Permanent Way, Bridges and Structures and Signals and Telecommunications	20	11
1182	Developments in the Hot Rolling of Steel Sections and Bars in Germany	9	6
1187	German Glazed Wall Tile and Sanitary Ware Factories	8	3
1203	Iron-Cored D.F. Loops and Manufacture of Iron Dust... ...	3	2
1207	Shellac: Stroever and Co., Bremen	1	1
F.I.A.T.:			
611	Design and Construction of High-Pressure Compressors and Reaction Equipment	4	6
620	Supercharged Loop Scavenging	1	7
728	A.G. Fuer Stickstoffduenger, Knapsack: Continuous Process for Manufacture of Calcium Cyanamide...	2	6
883	Effect of Metallic Additions and Impurities on the Galvanising Properties of Zinc	2	6
885	Manufacture of Synthetic Caffeine	1	6
896	Aludrine Sulphate: Manufacture and Pharmacological Properties	2	1
924	Investigation of Pure Oxide Ceramic Materials Intended for High Temperature and High Stress Applications	2	7
957	The Manufacture of Alginic Acid Derivatives and their Use as Emulgators in Emulsion ("Distemper") Paints...	0	7
963	The Synthesis of Digitalose: Report in German	1	1
964	Regarding the Resistance to Temperature Variations of Zygotes of Chlamydononas: Report in German	1	1

A list of all reports published up to and including October 26, 1946, classified under broad subject headings, is now available at the price of 6d. (post free 8d.). Supplements to this classified list will be published monthly at the price of 2d. (post free 3d.) and will be consolidated from time to time. An annual subscription of 4s. (including postage) will cover the October, 1946, consolidated list and all future supplements and consolidations up to and including September, 1947.

An alphabetical subject index of all reports published up to and including July 27, 1946, entitled "Technical Index of Reports on German Industry," compiled by the Australian Scientific and Technical Mission in conjunction with B.I.O.S. Secretariat, is also now on sale at the price of 5s. (post free 5s. 3d.). Further parts will be published in due course.

An almost complete set of German patent specifications, accepted by the Berlin Patent Office during the war, has been secured for the United Kingdom. The specifications, for which either annual or weekly subject matter and name indices are available, can be seen by the public at the Patent Office Library, 25, Southampton Buildings, Chancery Lane, W.C.2. Both the indices and the specifications are in German. Photographic copies of any specification and drawings may be obtained at the rate of 6d. per page.

Further reports, as they become available for publication, will be notified in *The Board of Trade Journal* and will also then be available for reference at the principal public libraries and Chambers of Commerce.

German Patent Specifications, accepted by the Berlin Patent Office during the war, may be seen at the Patent Office Library, 25, Southampton Buildings, Chancery Lane, W.C.2. Photographic copies of any specification and drawings may be obtained at the rate of 6d. per page.

B.I.O.S. Information Section, 37, Bryanston Square, W.1., which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive inquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

Contracts

WILD-BARFIELD ELECTRIC FURNACES, LTD.—has received an order for the supply of heat-treatment equipment to the aero engine factory of the Turk Hava Kurumu, Ankara, which is to manufacture the de Havilland "Gipsy" engines. The plant consists of modern electric furnaces of the "Heavy-Hairpin" type for general heat-treatment, vertical forced air circulation furnaces for the tempering of steel parts and the heat-treatment of light alloys, and low temperature electric ovens for paint drying and other applications. A large amount of ancillary equipment is also being supplied.

A Seven-Day Journal

The Machine Tool and Engineering Exhibition

The Machine Tool Trades Association announces that it will stage an international exhibition at Olympia, London, late in August, 1948. It will be called the Machine Tool and Engineering Exhibition, London, 1948, and further details are to be issued at a later date. This will be the first exhibition of its kind to be held in London since that at the Olympia in 1934. The Association states that it understands that there has been widespread speculation about the exhibition, and this brief preliminary announcement has been issued to clarify the situation.

Scientific Data and Metric Equivalents

In the course of the session of the Royal Society Empire Scientific Conference, last July, which was devoted to the consideration of greater uniformity in standards of measurement, the following resolution was adopted :—" If textbooks and scientific data or memoirs are expressed in systems other than metric, conversion factors or the metric equivalent should be included." The object which it was intended to achieve by this resolution was to make British scientific papers more intelligible to overseas readers, only familiar with the metric system. A letter signed by Sir Robert Robinson, Sir Henry Dale, Sir Edward Appleton, Sir Charles Darwin, and Sir Clifford Paterson, representing the Royal Society, the British Association, the Department of Scientific and Industrial Research, the National Physical Laboratory, and the British Standards Institution has been sent to all scientific societies and engineering institutions, asking that this proposal and the best means of implementing it should be considered. Should the councils or governing bodies of those institutions and societies find themselves in general sympathy with the proposal it is suggested that a meeting should be called at a convenient date, at which any special points of difficulty could be discussed, and if possible a fairly uniform system worked out which could be recommended to publishers of journals and textbooks. It is intended as far as possible to implement this resolution in reports of D.S.I.R. work published through the Stationery Office, and the Royal Society is also proposing to implement the resolution in its own publications. Any correspondence on the subject of this letter should, it is requested, be addressed to the Director, the National Physical Laboratory, Teddington, Middlesex.

National College of Horology

It is officially announced that a National College of Horology and Instrument Technology is to be opened in October next at the Northampton Polytechnic, St. John Street, London, E.C.1. Sir Allan Gordon Smith has accepted the invitation of the Minister of Education to be chairman of the Board of Governors, and Sir Harold Spencer Jones, the Astronomer Royal, will be the vice-chairman. Dr. J. E. Richardson, B.Eng., M.I.E.E., A.M.I. Mech. E., is the Director of the College, and Mr. R. A. Fell, M.A., the Head of the College. The heads of the various departments are the heads of the Polytechnic departments. Training will be based on a high degree of practical skill in the use of hand tools, and the most modern types of machinery required for the complete production of watches and clocks, and other fine mechanisms. For this purpose a comprehensive range of machine tools designed to produce every detail of watch and clock movements has been installed in the College workshops. The general course will be one of three years' duration, normal admission being from the age of sixteen to seventeen. If there is a sufficient demand, a part-time general course, meeting on two days each week and occupying five years will be started to meet the requirements of local firms. Following on the general course will be an advanced course of two years' duration. It is anticipated that qualified candidates on release from H.M. Forces may seek admission to this course by the aid of grants under the Government Further Education and Training Scheme. A post-graduate course of one year's duration has also been arranged. From time to time it is expected that short full-time courses in the manufacture of horological products will be held. Diplomas will be granted to successful students attending the major full-time courses. The fees for full-time courses will be £60 per annum. Six Scholarships per annum will be awarded by the Board of Governors. The dates of the opening session terms will be : Autumn term, Monday, October 6, to Friday, December 19, 1947 ; spring term, Monday, December 29, to March 24, 1948 ; summer term, Monday, April 5th, to Friday, July 23rd. Further particulars and forms of admission may be obtained from the Head of the College or the Secretary.

The British Institute of Management

The Council of the British Institute of Management announces that it has appointed the Hon. Leo Russell to be Director of the Institute. Mr. Russell is to take up the appointment as soon as he can be released from his present temporary post at the Board of Trade, probably in the early autumn. The Hon. Leo Russell is forty years of age and is the fourth son of the late Lord Ampthill. He was educated at Eton and before the war held a senior managerial position in a well-known weekly newspaper publishing firm. During the war he served on the General Staff, at various army headquarters, including the headquarters of the 21st Army Group, where, as Colonel, General Staff (Plans), he was concerned in planning the invasion of Normandy. He was in charge of Field Marshal Montgomery's Tactical Headquarters during the early stages of the invasion and was subsequently promoted to the rank of Brigadier. Mr. Russell joined the Board of Trade as an Assistant Secretary on his release from the Army. It will be recalled that the appointment of the first Council of the British Institute of Management was announced early in January this year. The Institute was set up on the recommendation of a Committee under the chairmanship of Sir Clive Baillieu, and it will receive a grant-in-aid from the Government of up to £150,000 over the first five years. The broad objects of the Institute are to provide a centre for the study of management ; to carry out research ; to disseminate information on the subject of management ; to encourage and advise upon schemes of training in management ; to work in close co-operation with those existing management bodies which are effective in their own specialist fields ; and generally to assist in raising the standards of management practice in this country.

Federation of British Industries

In a speech delivered to the Midland Region members of the Federation of British Industries on Friday, July 25th, Sir Clive Baillieu, Past-President of the Federation, dealt with the plans and prospects of industry, and the present economic position. The control and operation of industry was, he said, a national trust, whether the responsibility was that of the State or whether it was in corporate or private hands, all must conform to the highest commercial standards. He called upon industry to give a lead to the nation by recapturing in these days the spirit and purpose which inspired it during the war. Methods and practices should be submitted to fresh and searching scrutiny. British trade, he reminded his hearers, had been built up upon quality in products, and in our overseas representatives. The sellers' market was gradually fading out, and it was necessary to exercise a wise restraint in our price policy in order to retain old markets and to gain new ones. Technicians ought, he said, to be given free rein to their ingenuity and resource to overcome the difficulties with which we were now faced. Much, he went on to say, could be done in this way, and it would add much to the overall efficiency and production of industry. Industry asserted that Government policies cut right across the achievemen- of national unity, and of that national production which the crisis demanded. We should be ready to accept the need for curtailing expenditure on all long-term capital projects, whether housing, schools or hospitals, and seek to make do with the equipment and resources which were immediately available. The coal we had must be produced, and priority should be given to re-equipment of machinery likely to be remunerative in terms of output.

A New British Helicopter

In our annual review of aeronautics for the year 1946, early this year, we illustrated the model of the Bristol type " 171 " helicopter. It is now stated by the Bristol Aeroplane Company that this new machine has just completed its first test flight. We may recall that it has been built to the design of Mr. Raoul Hafner, and it provides accommodation for the pilot and three passengers. It is of all-metal construction and is powered with a single radial air-cooled engine with a designed output of 450 b.h.p. Its range is about 200 miles and it has a normal cruising speed of about 100 m.p.h. The single main rotor has a diameter of 47ft, and there is an airscrew at the tail to counteract the torque of the main rotor. A constant-speed governor controls the engine throttle and so relieves the pilot of the need to adjust his engine throttle when altering the pitch of the main rotor of the machine.

Generation of Electricity, 1946

Particulars of the units generated and the fuel consumed in generating stations in Great Britain during the year ended December 31, 1946, are given in a recent Stationery Office publication, " Generation of Electricity in Great Britain " (price 2s. 6d. net). This publication contains analyses and summaries of returns made to the Electricity Commissioners by authorised electricity undertakers covering the operation of 344 stations compared with the 346 stations included in the corresponding returns for the previous year. The decrease is accounted for by the discontinuance of generation at five stations before January 1, 1946, while three existing stations which did not generate the previous year were brought into operation. During 1946, the 344 stations operated by electricity undertakers generated a total of 41,252,550,045 units, an increase of 10·6 per cent over the corresponding figures for 1945. These stations consumed 25,482,933 tons of coal and coke, an increase of 11·7 per cent over the preceding year, and 34,067 tons of oil fuel as compared with 19,741 tons in 1945. Of the six stations that generated more than 1000 million units each in 1946, Battersea (London Power Company, Ltd.) showed the lowest average fuel consumption—0·96 lb per unit sent out, with a thermal efficiency of 26·49 per cent. There are nineteen stations generating between 500 and 1000 million units, and of these stations Kearsley (Lancashire Electric Power Company), had the lowest fuel consumption. Thirty-eight stations, numerically the largest group, are included in those stations that generate between 200 and 500 million units each, and in this group the lowest average fuel consumption, 1·05 lb per unit sent out, was maintained by Llynfi (South Wales Electric Power Company) with a thermal efficiency of 26·17 per cent.

Lighthouse Engineering

By K. C. SUTTON-JONES, Stud. Inst.C.E.

No. IV—*(Continued from page 72, July 25th)*

RAPID developments in the generation and distribution of electricity in the past few years have resulted in greatly extended application of electric power to lighthouses and lightvessels. Whilst the supply of electricity to the lightsource is the primary function, it is becoming customary to supply domestic, fog signalling and radio beacon circuits off the power plant also.

Power Supply

Special gas-filled filament lamps consuming up to 6-kW rating have been developed with filament shapes to suit the

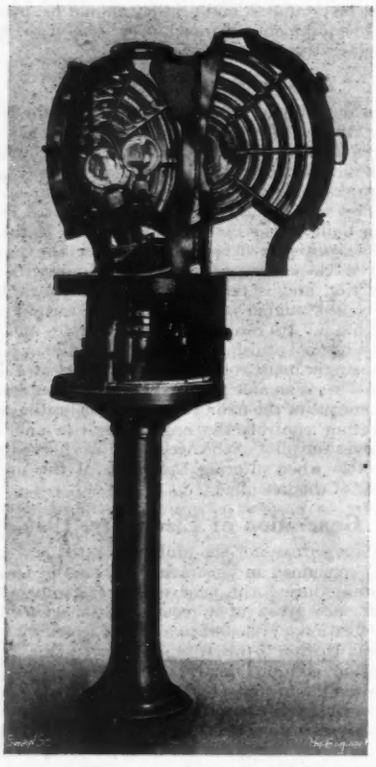


Fig. 14—Fifth Order Single Flashing Optical Apparatus Lampchanger and Duplicate Rotating Motors

many requirements, both optical and directional. The "flat-grid" filament emits the bulk of its intensity in a direction normal to the plane of the grid. The "triple-bunch" arrangement with its three separate paralleled filaments safeguards complete extinction of the light. The "coiled-coil" filament gives a high concentration and with the "cylindrical," "cruciform" and "bunch" types is suitable for all-round distribution. The "wreath" is the type found in "general service" lamps, and has little application in lighthouse engineering.

Lamps are now being fitted with "prefocus" caps, which ensure that once the first lamp is correctly focused the lamps following may be fitted without further adjustment. Focusing of small lightsources has to be carried out with great care and special focusing telescopes are now used to facilitate setting.

The nature of the electric supply depends upon the conditions at the light station. Some localities have power lines running within a short distance of the light station, whilst others are completely isolated and require generating plant on site. Furthermore, this isolation may mean that the light has to be left unattended for considerable periods. All this being considered, it will be evident that much skill is required on the part of the lighthouse engineer in the electrical field.

It is deemed advisable to provide standby lamps, a lamp changer (as described in the first article), motors for rotating the optic panels and a standby power supply unless the station is attended and the standby illuminant is provided by an oil burner.

Where the mains supply is run to the lighthouse it is customary to provide either a time switch with solar compensation or an automatic light switch for switching on and off. In one system, the lamps are fed through a transformer, which reduces the voltage so that in the event of mains supply failure the electricity may be provided by a battery of reasonable dimensions. This battery is kept charged through a rectifier and transformer operating off the mains during normal operation, and by a small engine generating set should the mains be out of commission for a longer period than the normal capacity of the battery will permit.

Many lighthouses, originally equipped with petroleum vapour lightsources are becoming electrified, the station remaining attended. In some cases the current is provided off the local supply and, upon its failure or failure of a lamp or optic-driving motor, the keeper places the "P.V." burner upon the lamp column, sets the burner in focus by means of a special adjusting arrangement on the column, pumps the oil to pressure, lights up and sets the clockwork mechanism in motion, the original clock having been retained as a standby source of rotating power.

Some lights are arranged to change over automatically from electric to gas, usually acetylene, upon mains failure, and whilst the system of oil and gas standby is considered to be sound, the emitted light intensity is reduced in most cases when such a standby is called upon on account of the superior brightness of electric lightsources. This points to the desirability of employing a standby lightsource of a power comparable with that of the main lightsource. It follows, therefore, that the ideal form of standby is one in which a standby supply similar to the main supply is generated and which is brought into operation automatically when required.

Lighthouse power plant is provided in duplicate, or even in triplicate and the generating sets are made to operate in sequence unless a failure of the operating set occurs upon which one of the other sets takes over duty. Such plant may take the form of either a battery which is charged by engine-driven generators or of direct-running engine generator sets, and either system can be arranged to operate manually, semi-automatically or fully automatically. The two latter systems result in the employment of fewer attendants and in some cases permit the whole lighthouse to operate unattended. It is necessary, however, to employ skilled labour for overhauling semi and fully automatic lighthouses and lightvessels. (Unattended lights are dealt with in the last article in this series.)

The choice of a direct-running or charge-discharge battery system is determined largely by the nature of the load. The direct-running system is selected where the load throughout the duty period remains fairly constant. Where, however, the load varies considerably the charge-discharge battery system is usually considered essential.

The direct-running plant usually comprises duplicate or triplicate engine-driven generating sets, each set consisting of a cold-starting solid injection engine coupled to the main generator. In the case of manually operated equipment the engines are cranked by hand,

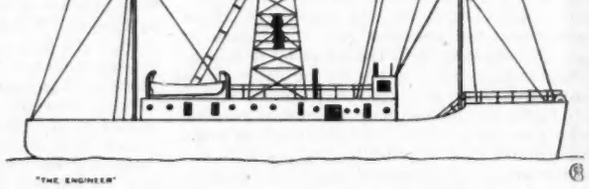


Fig. 15—Lightvessel "Terchellingerbank"

semi-automatic and unattended sets are coupled to a special starter motor which provides the cranking power. The starter motor circuit includes a low-voltage starter type battery, the circuit being closed by push button in the case of semi-automatic plant and either by a light-sensitive switch or by a solar time switch where the equipment is unattended. Once the engine has been started the starter battery is recharged by separate windings on the starter motor acting as a generator. Automatic selector switchgear is often provided so that the plants start in sequence. The switchgear is further arranged in such a manner that in the event of a set failing to start or stopping during a duty period the second set acts as a standby and carries on with the duty until the faulty set has received attention.

The charge-discharge battery system comprises a full-voltage storage battery which is charged by means of duplicate engine-driven generator sets, each comprising a cold-starting solid injection engine coupled to a special main generator. The sets are stopped automatically upon the completion of the battery charge and the alternate running and

starting systems are employed as described for direct-running plant.

In both systems provision is made for adequate engine protection against such eventualities as lubricating oil pressure failure, excessive cooling water temperature, &c. All sources of failure are brought to the attention of the servicing engineer when visiting the lighthouse by a most ingenious system of alarms, the circuits for which are usually operated off the starter battery. Operation of the lamp changer, change-over of optic motors or power sets are all made known by alarm bells and flag indicators. Power plants of the types described are now in operation all over the world, notably New Zealand, where much enterprise in the field of automatic equipment has been evident of recent years. A typical lightvessel power plant installation will be described in the last article in this series.

Fog Signals

Notwithstanding the wonderful ingenuity that is displayed in the concentration of light into powerful beams, it is of small account when fog settles upon the sea. In the calm which usually attends fog lurks great danger for the mariner. Devices recently perfected have proved effective in piercing this "blanket," and these, together with audible signals, constitute the seafarers' armour against the fog hazard. Many forms of audible signal have been employed, but these now fall into two groups: aerial and submarine. The transmission of sound through the atmosphere is subject to serious variations. Certain areas exist which are opaque to sound and whilst a signal may be heard at a distance of 20 miles the range may be, on another occasion, as low as a few hundred yards. Transmission through water is more reliable, the medium being more homogeneous. Nevertheless, it is usually found necessary to install special amplifiers for the reception of submarine signals, but this reception is also hampered in time by marine growth.

Aerial signals, of the audible type, take the form of explosive, diaphone, siren, reed, bell, oscillator and whistle signals. Most British rock light stations are equipped with explosive fog signals. One type employs a davit pivoted to the lantern roof at its point of balance and arranged to rotate by means of a bevel gear wheel and pinion, being operated by handwheel either from the lantern or lantern gallery. Four-ounce charges of guncotton are wired to the connections at the davit head and are detonated by a spark produced by a magneto housed within the lantern. Premature firing is obviated whilst the davit is in the lowered loading position by a special safety cut-out device which completes the electrical circuit only when the davit is in the raised position with the charges above the lantern. Magnesium powder is sometimes included in the charge, which has the effect of producing a flash with the explosion. Another type of explosive signal is the acetylene gun, in which a mixture of air and acetylene is ignited automatically. This was devised by Messrs. D. and C. Stevenson, the Scottish lighthouse engineers, and is in operation in a number of lighthouses in the service of the Northern Lighthouse Board.

Perhaps the most powerful sound producer of all is the diaphone. This instrument consists of a chamber, in the walls of which are cut a number of parallel slits. Concentrically disposed within the chamber is a cylindrical hollow piston with similar slits and a flange at one end, the whole being enclosed within an outer casing. Air at 35 lb per square inch pressure is admitted into the outer casing, driving the piston backwards and forwards with great rapidity. The result is that air effects its escape through the slits when they come into line in intermittent puffs. The sound produced (180 vibrations per second) is very pure, of indescribable volume and has a distinctive grunt or, in some cases, lowering of the note at the end of the blast. Reports indicate that the diaphone, the larger types of which consume up to 60 cubic feet of free air per second of blast, has been heard as far distant as 40 miles. On shore stations in the Trinity House lightservice two instruments are usually arranged to sound together, the trumpets sharing the angle of distribution. For all-round distribution as required on a lightvessel it is customary to employ a vertical resonator with a special distributing plate mounted above the mouth. This is only partially effective in directing the sound horizontally, however, and it is interesting

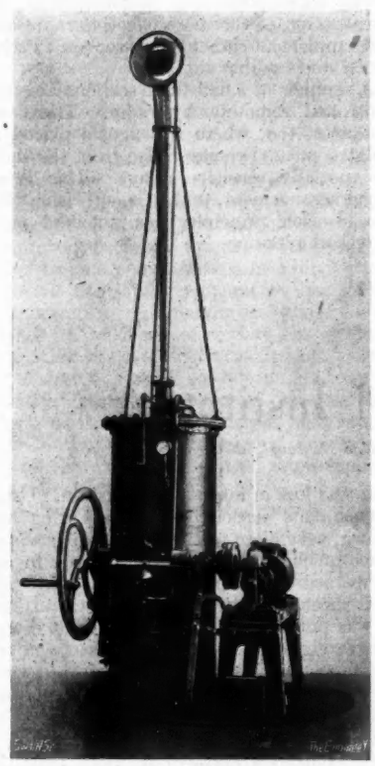


Fig. 16—Power-Driven Reed Fog Signal with Standby Hand Operating Gear

to note that in the service of the Commissioners of Irish Lights successful results have been obtained by placing the resonator at an inclination of 45 deg. to the horizontal. A typical lay-out of diaphone plant is given in the last article in this series.

Disc and cylindrical sirens operating off compressed air are also widely used for fog signalling. Rotors and stators are employed, each being perforated and the sound is produced upon compressed air impinging upon the rotating perforated discs or cylinders. The power of rotation is usually derived from the air main through an air motor, the sounding air being admitted the instant the rotor reaches nominal speed, thus maintaining a steady note, usually at about 190 vibrations per second. Fog sirens are sounded at a pressure of 25 lb per square inch from horizontal tapered elliptical trumpets and from vertical conical horns having bent tops.

Reed signals consist of a throat in which are fitted steel reeds tuned to emit a note of 450 vibrations per second—much higher than the note emitted by the siren or diaphone. Two sizes of signal are employed, both of which have proved very creditable in service. The manually pumped signal sounds at an air pressure of only 5 lb per square inch, whilst the power-driven types operate off a pressure of 15 lb per square inch.

Perhaps the most recent addition to the field of sound emitters is the electric oscillator, which employs a magnetically operated diaphragm. Although it can hardly be claimed that the oscillator is as powerful a sound producer as the diaphone, it has certain advantages over the latter. The need for bulky air receivers and piping is dispensed with. There is not the restriction in the duration of blasts, and so on. However, the sound output per horsepower is higher for the diaphone. A very successful oscillator installation was the one aboard the Netherlands lightvessel "Terchellingerbank." In this installation four separate emitters were placed in a bank beneath the lantern (see Fig. 15), being fixed within the openwork tower structure. The instruments emit a note of 300 vibrations per second and are placed half a wavelength apart, which is claimed to have the effect of increasing the sound range horizontally. Each emitter is rated at approximately 2 kW and the range claimed for the signal is 7 miles.

As stated above, oscillators are also sounded beneath sea level and are, in some cases, synchronised with aerial or radio beacon signals. This enables a comparison to be determined between the time taken for sound to travel through the respective media and to enable computation of distance to be made. Various systems and combinations of signals have been employed from time to time, notably the "Talking Lighthouse" at Cumbrae, off West Scotland, and the duplex system of fog signalling in which two signals are placed one on either side of a harbour entrance. The signals emit different tones, but sound simultaneously. To a vessel steering a true course between them they are received at the same instant. Deviation from this course involves the reception of one signal before the other.

In addition to visual and audible warnings, means have been installed at many light stations throughout the world for transmitting radio signals, which are receivable by vessels equipped with radio direction-finding equipment. Each light station, so equipped, is arranged to transmit a Morse code letter signal at intervals arranged internationally so as to reduce the interference on the wave band employed (in the region of 1000 m). As an example of this system the first radio beacon encountered when approaching the English Channel from the south-west is at Round Island lighthouse, Scilly, which transmits "GGG," followed further up the channel by "GSM" (Start Point lighthouse), "GCM" (Caskets lighthouse), "GAM" (Nab lighthouse), "GDM" (Dungeness lighthouse), and so on.

Further appliances introduced during the war are having their application to marine navigation.

There is little doubt that shipboard radar will be of very great value during thick weather and as proof against collision, &c., but there seems to be little cause for resorting to its use during clear conditions when the mariner may use his senses directly and establish his position instantly without the need for complicated instruments. Furthermore, it is false to assume that all ships are likely to carry radar equipment, the men to

operate it or the means for servicing it, although most large vessels almost certainly will do so.

In order to satisfy the requirements of vessels so fitted, it will probably become necessary to equip certain lighthouses and lightvessels (especially along low-lying parts of the coast where a poor P.P.I. reflection is given) with coding responders whereby radiations reflected from such points may be identified on the plan position indicator to form an indication of bearing and range, or with "ramarks"—a means of giving a bearing line on the P.P.I.

Smaller classes of vessels (*e.g.*, coaster and fishing craft) will require a radio aid which does not involve expensive and complicated equipment and the attention required with shipboard radar. The radio beacon referred to above provides one answer, although not one of the accuracy obtainable with the Decca or Consol systems.

The Decca system was used for guiding the leading minesweepers and landing craft on "D-day." Radio signals, continuously emitted from transmitters situated ashore, actuate a special form of receiver, which latter has dials showing markings of different colours, and the relation of these to a special chart gives an exact and instantaneous geographical position. Charts covering the service area of the transmitters are "gridded" with a series of numbered coloured lines. At any time when a position is required it is necessary merely to read off the numbers indicated on the meters and look for the corresponding numbered lines on the chart. The point of intersection of the coloured lines gives the position. The line position accuracy claimed by those responsible for this system is to within 150 yards by day and 800 yards by night, at a distance of 250 miles from the principal transmitter. Difficulty in identifying a particular "lane" when entering the service range was experienced, but it is understood that this has been overcome in the latest equipment.

The rotating beacon formerly operating at Orfordness Lighthouse served a useful purpose. In this type, a signal was emitted every time a rotating radio beam passed through north and east. Thus the difference between the reception of the beam and the signal would give directional indications.

Development of any of the above processes may require the provision of special equipment aboard major light stations, although much planning, design and international agreement has to take place before we have a precise picture of things to come.

The indications are, however, that the introduction of the more effective radio aids will supplement rather than supplant existing visual and audible aids.

A number of small light stations are now controlled remotely by radio. There are instances, too, where fog signals placed at isolated points are controlled from the shore by specially sensitive relays. This is no novel arrangement, and it is surprising that use of such principles has not had more universal adoption.

(To be continued)

Iron and Steel Institute

No. II *(Continued from page 84, July 25th)*

WE conclude our report of the Summer Meeting below. Discussing R. Durrer's paper on "The Production of Iron and Steel with Oxygen-Enriched Blast," Mr. J. W. Reber (Wellman Smith Owen Engineering Corporation, Ltd.) said that when one calculated flame temperature using oxygen one obviously obtained a certain theoretical temperature which was never achieved, because dissociation played a great part in it, and dissociation increased with a rising temperature and a rising oxygen mixture. The result of a calculation was that with 50 per cent oxygen admixture, with oxygen at 90 per cent purity, the rise in temperature on the theoretical side without dissociation was about 400 deg. Cent., and reached the high figure of 3150 deg. Cent., but when allowance was made for dissociation the rise in temperature was only about 130 deg. Cent. Those calculations had been based on work already carried out, but when temperatures exceeded 2500 deg. Cent. the dissociation reactions taking place were not very much known, because there were further reactions with OH and atomic oxygen, and it was difficult to be certain about them. The fact remained that with either coke oven gas or oil the temperatures were about the same line; there was very little difference. That meant that if one got a higher yield with an open-hearth furnace using oxygen-enriched air and oil it was not so much a question of the increase in flame temperature as such, though that did occur, but rather a question of quicker mixing. In an ordinary open-hearth furnace one got only about 80 per cent of the actual temperature in the furnace; the other 20 per cent was lost in internal combustion. Using oxygen, and especially, as Mr. Thring had shown, very close to the gas stream, one got much quicker diffusion and therefore a higher temperature. It was that which gave the high throughput in the open-hearth furnace. It was not so much that the present design was wrong, but the mixing was late, and one got much quicker mixing in using oxygen. It was not due so much to the theoretical rise in temperature.

Professor Dr. R. Durrer replied shortly.

The following papers were then discussed together :—

HYDROGEN AND TRANSFORMATION CHARACTERISTICS IN STEEL[5]

By Professor J. H. Andrew, D.Sc.,[6] H. Lee, B.Eng., Ph.D.,[6] H. K. Lloyd, B.Sc.,[6] and N. Stephenson, B.Met.[6]

Synopsis

A comprehensive study of the evolution of hydrogen from steel has been carried out, and results obtained for twenty-two different steels, hydrogen-soaked and cooled in vacuum under identical conditions, are reported. It is shown that in all cases relations between hydrogen evolution and transformation characteristics are marked and that there is a pronounced increase in the rate of evolution corresponding to the gamma-alpha change. The manner in which hydrogen is evolved from a steel is shown to be closely linked with the mode of transformation, but such a correlation does not necessarily determine the amount of hydrogen retained after cooling.

The effect of alloying elements upon hydrogen evolution from steel is discussed, and it is deduced that hydrogen diffusivity in the alpha range may vary with the composition and treatment. It was found that when nascent hydrogen was generated by electrolytic action on the surface of a steel specimen, both the rate of diffusion and the solubility at room temperature depended upon the structure of the steel.

Experiments on the removal of hydrogen from steel under isothermal conditions, as outlined in a previous paper, have been continued, and the results confirm the conclusion that the optimum temperature of hydrogen removal corresponded with a rapid transformation. Crack formation in isothermally treated specimens has been discussed, and certain anomalous results of crack formation previously observed for plain carbon and nickel steels are explained in terms of the effect of structure upon hydrogen diffusivity and solubility at room temperature.

In the presence of hydrogen, the transformation of a 3 per cent chromium steel under isothermal conditions was slightly slower at 700 deg. Cent., otherwise hydrogen was found to have no retarding effect upon isothermal transformation. The nature of the isothermal-transformation product has been studied, and it is shown that with a 3 per cent chromium steel containing 0·2 per cent of carbon, 480 deg. Cent. was found to be the critical temperature dividing the formation of chromium carbide (Cr_7C_3) and cementite (Fe_3C). Isothermal-transformation diagrams based upon dilatometric measurements are given for the chromium steel as well as for a 3½ per cent nickel steel.

Hydrogen embrittlement was found to vary with the thermal treatment of steel, and it is shown that with a 3 per cent chromium steel the presence of hydrogen to the extent of 3cc/100g may or may not cause an embrittling effect, according to treatments given, and the elongation and reduction of area are affected differently by hydrogen. It was also found that the distribution of hydrogen in a tensile test-piece had a marked effect upon its mechanical properties.

It is considered that hydrogen embrittlement and hair-line cracks are closely associated with each other, and that hydrogen diffusivity and solubility are the controlling factors for both. The view previously expressed to explain hair-line crack formation has been modified, in that the sudden evolution of hydrogen at the crack formation does not necessarily involve the breakdown of a hydrogen-rich constituent. Whilst hydrogen is the fundamental cause of hair-line cracks, stresses are important in that they may affect the diffusivity and solubility of hydrogen. Unless results of hydrogen diffusivity and solubility in steel for various conditions are available and the effect of structure and stresses upon them is thoroughly understood, controversies regarding the cause and mechanism of hair-line crack formation cannot be settled.

[5] Received March 13, 1947.

[6] University of Sheffield.

HYDROGEN IN STEEL MANUFACTURE[7]

By C. Sykes, F.R.S.,[8] H. H. Burton,[9] and C. C. Gegg[10]

Synopsis

A number of determinations have been made of the hydrogen content of plain carbon and alloy steels at different stages of manufacture, viz., in the electric-arc and open-hearth furnace, and in ingots, billets and forgings. The experiments on semi-finished products confirmed the results of previous work on steels artificially impregnated with hydrogen and indicated that ductility is reduced with hydrogen contents in excess of 2cc/100g. Even when steel is melted under carefully controlled conditions, hydrogen contents of 4–6cc/100g are to be expected, which will adversely affect ductility if not removed. A study of the effects of various heat-treatments on hydrogen contents and susceptibility has shown that relatively high hydrogen contents do not automatically lead to hair-line cracks. No conclusive evidence was obtained on the question of segregation, although some alloy-steel ingots and forgings showed wide variations in hydrogen content. On the basis of certain assumptions, data on permeability and solubility have been used to calculate values for the diffusivity of hydrogen, which have made possible the prediction of the rate of loss of hydrogen from steels at temperatures down to 400 deg. Cent., at relatively high hydrogen concentrations. The results of the experiments are discussed in relation to the theories put forward by other workers on the subjects of hydrogen in steel and hair-line crack formation.

Discussion

The President (Dr. C. H. Desch, F.R.S.) said that the papers represented a very large amount of work undertaken by the Hair-Line Crack Sub-Committee. When the problem became important, the question

[7] Received April 2, 1947.

[8] Messrs. Thos. Firth and John Brown, Ltd.

[9] English Steel Corporation, Ltd.

[10] Brown-Firth Research Laboratories.

of hydrogen was at once raised. There were some sceptics who were doubtful whether hydrogen played any part in the phenomenon at all, but he thought that the work which had gone on had shown that, whilst other factors had to be taken into account, hydrogen was the most important of all. Although the problem had not been completely cleared up, very great progress had been made. At first sight it might seem that the solubility of so small an atom as hydrogen and its diffusion through a lattice would be very simple, but it had proved to be exceedingly complex, and in the second paper there was considerable discussion of the physics of the process. So far as a practical solution was concerned, he thought that many steelmakers knew how to produce steel free from hair-line cracks provided they had plenty of time. It was always when pressure of work had been very acute and forgings had to be prepared quickly that there had been most trouble with hair-line cracks.

Dr. M. L. Becker (British Iron and Steel Research Association) said it had now been shown that the hydrogen was deleterious, though not the sole cause of cracking. He wondered why more attention was not paid to getting rid of the hydrogen entirely, as Dr. Sykes had suggested. It was in the liquid state that the hydrogen could be got rid of most easily, and he suggested that in the liquid state the hydrogen could be driven out by bubbling through an inert gas. Such an inert gas must clearly not be nitrogen, because that would be absorbed in the steel, while oxygen or CO_2 would react with the steel too rapidly. He could only think, therefore, of carbon monoxide. He felt that if the experiment of bubbling carbon monoxide through had not been tried it ought to be. It might seem a little difficult from a practical point of view, but he felt sure that that could be overcome. By bubbling it through it should be possible to get rid of the hydrogen.

Dr. C. Sykes replied shortly.

On July 11th the first paper to be discussed was the following :—

OBSERVATIONS ON CONDUCTING AND EVALUATING CREEP TESTS[11]

By W. Siegfried[12]

Synopsis

The paper describes sustained-load tests carried out on various highly heat-resistant alloys used in the construction of gas turbines. The results of these tests are evaluated in the light of the main problems presented by gas-turbine design.

A much longer life is required of stationary gas turbines for power plants and marine-propulsion duties than of aircraft gas turbines. The question of extrapolation over long periods (more than ten years) is therefore dealt with.

The tests described also broach the problems of three-dimensional stressing at high temperatures and the influence of notches on hot strength.

The results of sustained-load tests on smooth and notched bars at high temperatures are set forth and discussed. A decisive influence on deformation figures in the sustained-load test and on the notch toughness is exercised by the testing time. Curves for various steels are given which furnish a good criterion of their toughness.

Discussion

Mr. D. A. Oliver (William Jessop and Sons, Ltd.) said that the British approach to the whole subject was fundamentally different from the approach of the author. They did not know much about it a few years ago, but they did know that it was complicated, and they found so much contradictory information associated with the simplest possible parallel tensile creep specimen or parallel hot tensile test that they had not got to the stage when they would be so bold about advocating the widespread adoption of the notched test-piece. On the other hand, they had not been entirely unmindful of the problems of notches and blade root fixings. When they had been concerned with the effect of notches in blade roots they had had recourse to photo-elastic studies, which, of course, gave a detailed solution only for the elastic case. They had still regarded that only as guidance and not as a final answer, and when it came to the question of studying the actual blade root fixing they felt that it was misleading to deal only with one blade dummy and one root fixing. They found that it was necessary to consider at least two blade root fixings on either side of a single blade under test. It would be very interesting to know whether the author himself had found that necessary, because there could be violent sideways reaction the moment the blade tried to pull out, and if one had not simulated the reaction conditions of real life one could readily get a false result ; either the fixing would be too stiff, because there was a lot of solid metal on either side or, if the test-piece had been made too narrow, there would be insufficient strength sideways, and that would give an unduly pessimistic result.

Mr. W. E. Bardgett (The United Steel Companies, Ltd.) remarked that the evaluation of notch sensitivity on the basis of the true stress contraction curves and notched specimens was undoubtedly a matter for serious consideration in evaluating materials for high temperature service, but it would be interesting to know how far the author considered that the evaluation on this basis might be simplified. Did he consider it possible to determine the relative notch sensitivity using one selected notch, or was it necessary to make the evaluation on a number of notches, and precisely how was the evaluation of the notch sensitivity made in relation to the S-curve ?

The author made the interesting suggestion of identifying the most important physical property which could be measured directly in a suitable way, and which was directly related to the change in condition affecting high temperature behaviour. This was to be applied as a check on the reliability of extrapolation of sustained load curves. This indirect method would require a very complete understanding of the high temperature characteristics to be applicable with sufficient certainty, and it was doubtful whether any shortened form of test would be of direct assistance in guaranteeing safety in machines, though it might well serve as a guide in the selection of those materials for further investigation. The great value of such a method of examination, if it were proved completely reliable, must be fully appreciated, and it was worthy of very serious consideration.

Dr. C. Sykes, F.R.S. (Firth-Brown Research Laboratories) said that in this matter one was dealing with variations in the method of precipitation, and the methods of precipitation, the metallurgical changes, could be investigated, he thought, quite satisfactorily without creep testing. The presence of a stress would probably accelerate the effect, but the effect would occur. He made that point because there was so much work which had to be done on creep machines at the present time that if some of these variables could be investigated without using creep machines other variables, such as the notch effect, would get more time on the machines. With regard to the notch effect, he thought that the theoretical position at high temperatures was very unsatisfactory. He had never been able to understand the arguments of Kuntze, and in any event he thought it was true to say that they were based on pure elastic theory and, for example, they assumed a value for the Poissons ratio which was not the value observed. He got the impression from the paper that cracking would be expected to be worse under tri-axial stress than under bi-axial. That, he thought, was what was generally believed. He would like to ask the author where the cracks started on the test-pieces in question : did they always start from the outside, or did they start some way in ? He thought that it would be useful from the practical point of view to know what elongation could be obtained under these notch conditions before any cracking started, because in many cases it was necessary to consider failure due not only to a sustained load but also due to fatigue. There was one further point which he could add to the complexity of the problem. They had examined one of their experimental steels. This material had quite a small elongation in the cold, and the reduction of area was about the same as the elongation ; in other words, at room temperature there was no necking. At elevated temperatures, however, substantial necking occurred. He thought it was true to say that in that particular steel there were no major cracks ; any cracks which started seemed to seal themselves up after a very short distance in. It might be imagined, therefore, that that material was not notch sensitive ; yet the fatigue properties of that material when notched were in no way superior to the fatigue properties of other materials which showed marked intercrystalline cracking on ordinary creep testing.

The author intimated that he would reply in writing.

Dr. C. Sykes, F.R.S., presented his Second Hatfield Memorial Lecture, " Steels for Use at Elevated Temperatures."

The following papers were jointly discussed with it :—

REQUIREMENTS OF STEEL FOR GAS TURBINES[13]

By H. R. Zschokke and K. H. Niehus[14]

Synopsis

When testing and evaluating heat-resistant steels for gas turbines used in peacetime on land and sea, other criteria must be taken into account than in the case of aeroplane turbines, especially those for military aircraft. This is due to the fact that in peacetime a life of many years is required, whereas for aircraft turbines a life of a few hundred hours is enough. This difference is especially important in the evaluation of creep tests on steels used for turbine blades. The alterations of the structure after long exposure to high temperatures need further exploration, and the value of various methods applied to raise the creep limit must be studied more carefully. Apart from the creep limit, the fatigue strength is of vital importance to the engineer, and the same applies with regard to the corrosion resistance of the blades and the combustion chamber. Here, too, the requirements are much more stringent than for aircraft turbines, since completely different fuels are used. The steels for the rotors, turbine housings, and gas ducts must likewise be selected most carefully on account of the high and varied stresses to which these parts are exposed. Scaling-resistant chromium steels often show a pronounced tendency to embrittlement. When used in combustion chambers they are in addition exposed to corrosion by oxidation and oil residues. Apart from heat resistance, good mechanical properties such as machinability, weldability, forgeability, and bendability are, of course, indispensable in practice.

The gas turbine was introduced in iron and steel works at an early date. Its first use was that of an auxiliary engine for the Brown Boveri Velox steam generator. Gas turbines working at tem-

[11] Received April 21, 1947.
[12] Sulzer Brothers (Winterthur), Ltd.
[13] Received March 24, 1947.
[14] Brown Boveri and Co., Ltd., Baden, Switzerland.

peratures of 500 deg. to 570 deg. Cent. proved satisfactory for this purpose, the working life in one case exceeding 70,000 hours. Experience has also been gained over many years with gas turbines, at a temperature of 500 deg. Cent., used in oil refineries for the Houdry cracking process, combustion turbines for use at 500 deg. to 600 deg. Cent., producing the air for blast-furnaces and steelworks, have also been brought on the market by Brown Boveri, and more are under construction, which seems to indicate that the combustion turbine will find interesting applications in iron and steel works.

THE SCALING BEHAVIOUR OF HIGH-STRENGTH HEAT-RESISTING STEELS IN AIR AND COMBUSTION GASES[15]

By W. Stauffer[16] and H. Kleiber, Dipl.Ing.[16]

Synopsis

In the gas turbine, as in any heat engine, the effective work is brought about by the combustion of fuel. The hot structural components are thus exposed not only to the mechanical stresses due to pressure, loads, and rotation, but also to the chemical attack of the combustion products. The investigation of the chemical resistance of the steels must be carried out in co-operation with the designer of the gas turbine, so as to co-ordinate the various requirements.

A new apparatus for carrying out scaling tests in gas mixtures, and the experimental technique are described. This apparatus was used for studying the effect of synthetic combustion gases with low, medium, and high sulphur contents on martensitic, ferritic, and austenitic high-strength heat-resistant steels. The results obtained, together with those of scaling tests carried out on the same steels in air, are presented in the form of curves.

Discussion

Mr. C. G. Conway (The Mond Nickel Company, Ltd.) said that the papers contained a wealth of detail on the properties of high-temperature materials. These data, when carefully considered, might help the engineer in his difficult task of designing heat engines, but without due consideration his task might well be all the more difficult. At the present time, the engineer wished to make use of materials which could operate for long periods of time at temperatures above 600 deg. Cent. In order to do that it was necessary, as the authors had pointed out, to make as full a use as possible of the data to be provided by laboratory experiments. At the same time, the engineer must not allow himself to be misguided by data which were not strictly applicable. While laboratory experiments could give indications of future behaviour, there could be no short cut; only by the results of service trials over long periods, coupled with full details of running conditions on materials chosen on the basis of reasonable and well-planned laboratory experiments could the answer be found.

Here he wished to differ radically from the statement made by Zschokke and Niehus; there was not, in his opinion, any theoretical basis for extrapolation of creep behaviour into the future. Since the maximum economic period of creep test was between 10,000 and 15,000 hours, the designer of, for example, an auxiliary turbine must base his design, and had done so in certain notable instances, on a component life of 20,000 hours, though he might have 100,000 hours in mind for the life of the installation. On that basis, the designer was unlikely to run into serious difficulty. When one was forced to make an extrapolation, the most conservative possible should be used. The double logarithmic method adopted in two of the papers presented that morning could lead to grievous error, and should be treated with great reserve.

It would be well at this time to consider the sources of error in creep testing, and examine their effect on the attitude to be adopted to the results obtained. Taking first the temperature obtainable, in any industrial laboratory this was a most difficult quantity to maintain. He would quote as an example a verbal report on one industrial country in Europe, in which a check on the measurement of the temperature in the 650 deg. Cent. region showed differences as great as 15 deg. Cent. between various industrial laboratories. To anyone with just a nodding acquaintance with the art of high-temperature testing, the effect of such a difference did not need to be described.

A major difficulty arose here, since the successful application of laboratory data to service depended on the determination of blade and disc temperatures, apart from the other components of the turbine, where the problem was more complex than in the laboratory. In any one laboratory the mean temperature difference between any two given creep tests could be placed at about 2–3 deg. Cent. on an average, due to temperature fluctuations over the course of the test differences in the thermocouple calibration and in the gradient along the specimen. Such a difference could give about 30 per cent error in the time to reach any given elongation. That could be readily seen by plotting the data on a temperature basis.

Other errors were of importance; the non-uniformity of cross-section of the test-piece, even from the best workshops, and the difficulty of maintaining true axial loading could lead to additional errors of about the same magnitude as those caused by temperature. It was thus necessary, in considering the course of a plot of stress against time, to map out the probable scatter band, preferably on a linear stress against logarithmic time basis.

Zschokke and Niehus were right to draw attention to the possibilities of structural change, which might have disastrous effects in a turbine installation. The evidence of change and deterioration must, however, be sought in the material itself, and not in data plotted on an artificial basis.

In criticising the double logarithmic plot, he would say that in his experience it did not give straight lines, and one would not expect it to do so. He would recommend that if on stress/log time plotted data there was definite evidence of progressive declination from the straight line outside the scatter band and towards the abscissa, then the quality of the material used in those tests should be examined exhaustively at the end of the test. That did not preclude examining the materials in any case.

To some extent his remarks on the validity of laboratory experiments applied to the paper by Stauffer and Kleiber. The conclusions, as the authors pointed out, were somewhat at variance with the general picture which one had in one's mind of the behaviour of the steels in question under such conditions. The apparent inhibition of attack by the presence of high sulphur had, he believed, been noted before in a catalytic plant under alternating oxidising and carburising conditions, and might be due to the prevention of carburisation.

He would repeat that there could be no short cut in this development; they must be willing to buy at least some of their experience.

Mr. D. A. Oliver (William Jessop and Sons, Ltd.) said he was rather more optimistic than Dr. Sykes about the solution of some of the difficulties relative to the higher alloyed steels for operation at the higher temperatures. In some recent work which they had undertaken they had, to their great satisfaction, found that the alloy segregation in some of the very complicated highly alloyed steels was surprisingly small as measured by taking an ingot, sectioning it, drilling it at different points and considering the gradient in alloy concentration. In dealing with very large rotor forgings it was wise not to take them up to the highest solution temperatures, and in cooling, which was often air cooling, the position again was not so bad, because if the centre cooled more slowly and was virtually tempered after solution treatment the properties which one observed in consequence of that were that the maximum stress and the proof stresses increased, and the creep resistance decreased only slightly. At the periphery of the rotor the full solution treatment had been obtained, and substantially a quench had been imposed. When one worked out the consequences of that, one found that it happened to go the right way, because one got the highest creep resistance in the hottest zones and had only to sacrifice a little creep resistance where the lower temperature properties were actually improved.

Mr. J. T. Mackenzie (United States Steel Export Company) said he had just seen the data presented regarding the δ phase, but in the experiments in their steel laboratories at Pittsburg on stainless steel they found that the δ phase could occur in austenitic steels with as low as 18 per cent chromium. It was generally in the combination of the higher molybdenum type of austenitic steels, but there had been repeated cases of 18 or 19 per cent chromium with nickel—the 18/8 type of steel—which showed δ formation on exposure to high temperatures, and the evidence indicated that it formed from the ferrite phase which was present due to the unbalanced nature of the alloy. On the other hand, experiment at the Carnegie Institute of Technology had shown that the δ phase could form directly from austenitic material, so that it was not possible to be absolutely sure that there was any lower limit in the chromium content in δ formation, as long as one had either ferrite formers or δ formers of the nature of molybdenum. That was a word of caution for high-temperature steels, because molybdenum was a familiar alloying element, and with high molybdenum types there seemed a definite tendency for the formation of δ phase even with very low chromium contents.

Dr. T. P. Hoar (Cambridge University) said that in some work which had not yet been published they had evidence that in a really very low chromium steel, containing less than 17 per cent chromium, but with additions of the order of 3 per cent molybdenum and 2·5 per cent silicon, δ formation could take place very readily in the range referred to. It was very unfortunate that the δ embrittlement occurred, because there seemed to be some evidence, perhaps of a rather tentative nature, that so far as scaling was concerned the formation of δ was no disadvantage, and might even give rise to a slight improvement.

Mr. W. E. Bardgett (The United Steel Companies, Ltd.) remarked that the work carried out by Zschokke and Niehus on the effect of cold work on creep was of particular interest, but the results given referred to relatively short periods of test. It would be interesting to know to what extent the results were modified by longer periods of testing. It did not follow that even a small amount of cold or warm work would improve the creep resistance. While cold or warm work might improve the creep resistance, it was possible that, as was pointed out in the paper, over-ageing might be unduly accelerated. Whilst that expedient had been resorted to in materials for aircraft,

[15] Received March 17, 1947.
[16] Escher-Wyss Maschinenfabriken A.G., Zurich.

where the true and total effect of the warm work could be evaluated, it was of questionable value when materials were subjected to service during periods beyond the normal range of testing. In either case the aim should be to provide materials which would give the desired properties without warm working, since the latter was open to the objection that it was not readily controlled and that the same optimum degree of work might not be possible for the components as a whole, and that a suitable method of selection of specimens might be difficult.

Dealing with combustion chambers, since these had only to carry their own weight it would be useful to have an assessment of the permissible degree of embrittlement. Obviously one would say that the notched bar impact test was too severe unless one considered, perhaps, quite a small value of impact, say, of the order of 5–10ft-lb, but the impact test would not then be a very suitable way of discriminating, and it might be that a bend test would give a better assessment of the material with regard to the embrittlement which could be tolerated in service.

Sir William Griffiths (The Mond Nickel Company, Ltd.) felt that if advances were to be made in this subject it would be necessary to take risks. The tendency of a technical body was perhaps to emphasise the difficulties of transferring the results obtained in the laboratory into practice and to point out all the difficulties involved in getting a proper assessment of the materials by laboratory measurements. He would be the last to decry the importance of those tests, but, when one considered the time involved in any creep test or long-time fatigue test at high temperatures, and the very many variables involved in any material which was being considered and in the test procedure, then if it was necessary to wait for absolute certainty, as indicated by the various curves obtained, remembering also that it was not yet known how those curves were affected in service, he feared that the development of the gas turbine might have to wait a long time.

At the same time, he would like to say to the engineers that while he was wholly in favour of initiating as promptly as possible tests of long duration, lasting thousands of hours, which undoubtedly must be carried out, he would remind them that the subject was still young, though it was ten years or more ago since temperatures of 650/700 deg. Cent. began to be investigated, and it might well be that while long-term tests were going on the materials with which they dealt would become out of date. By the time the end of a 10,000-hour test had been reached, a great deal would have been learnt about the metallurgical side of the material being tested, so that by the time the test was over the material might well be already out of date. That did not mean that they should not go ahead, but they should go ahead with practical tests as well as with laboratory experiments, and make use of that great standby of the engineer, the factor of safety, which gave that experience which had now been built up in the steam turbine field, and which it was hoped might bring about in the same way quite a large use of the gas turbine with the use of materials which, if they were not already available, he felt sure would be available by the time that the engineer required them.

Dr. Sykes and Mr. Stauffer intimated that they would reply to the discussion in writing.

Mr. K. H. Niehus replied shortly.

The Public Works, Roads and Transport Congress and Exhibition

No. II—*(Continued from page 76, July 25th)*

IN this article we describe a further selection of exhibits shown at the exhibition which closed on Saturday, July 26th.

Barber-Greene Olding and Co., Ltd.

A finishing machine designed to lay a compact level course of bituminous mix on roads was exhibited by Barber-Greene and Olding, Ltd., of Hatfield, Herts. This machine, which is illustrated in Fig. 7, lays surfaces varying in thickness between ½in to 6in and from 8ft to 12ft wide in increments of 3in. Its speed is variable from 8ft to 44ft per minute, and the laying capacity of the machine is stated to be 80 tons of material per hour.

Surfacing material is delivered to the finisher by lorries which dump the mix into a 5-ton capacity hopper at the front. The machine is self-propelled on trackless tracks, and, to avoid interruption in the laying operation, the supply lorries are pushed forward at the working speed by rollers at the front of the machine whilst the load is being dumped. A series of bar feeders moving along the bottom of the hopper feeds the surfacing material through adjustable gates on to spreading screws. Behind these screws is a curved deflector plate and a tamper which compacts the material deposited on the road surface. The tamper has a vertical reciprocating movement of ⅛in at 1200 strokes per minute, and it is followed by a screed which smooths the surface to give the required finish. This screed can be heated by means of a blast of hot air when the finisher is engaged in spreading hot materials.

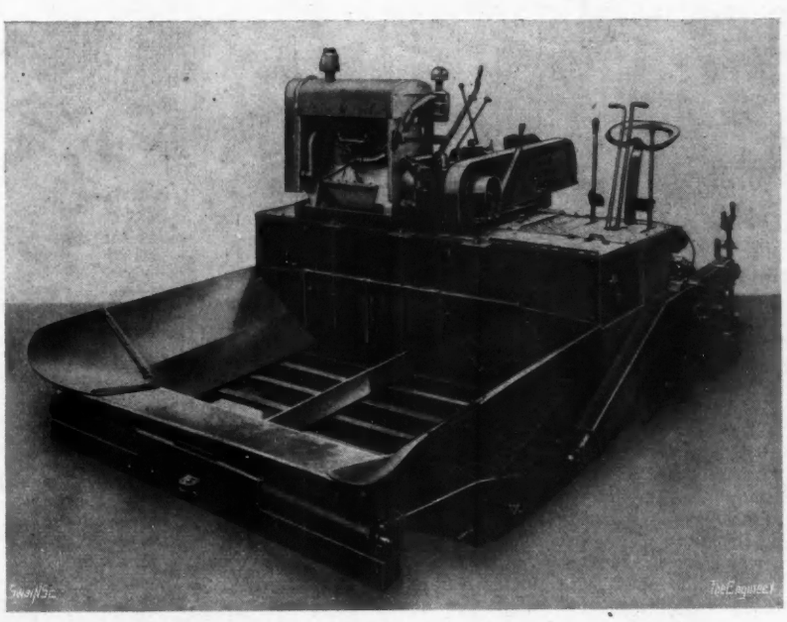


Fig. 7—Bituminous Road Finishing Machine—Barber-Greene, Olding

The driving and operating controls are situated on one side at the rear of the machine, and dual controls are also fitted on the other side of the machine. At either set of controls an operator has an unobstructed view of the mat edge on that side of the machine.

Lagonda, Ltd.

A new diesel pile-driver made by Lagonda, Ltd., Staines, was shown as a full-size complete pile-driving unit. This pile-driver is of simple construction and is light and easily handled.

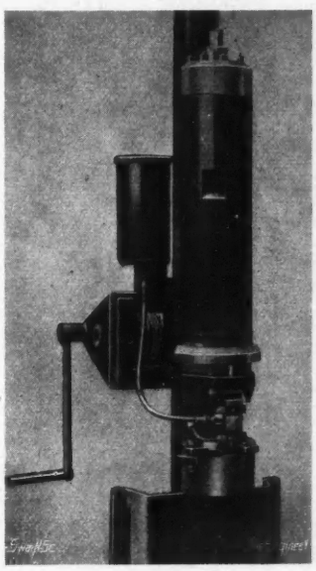


Fig. 8—Diesel Pile-Driver—Lagonda

As can be seen from the drawing we reproduce in Fig. 9, it comprises a base, or anvil A, from which rises a stationary piston-rod B carrying a piston C on the top of which is the fuel nozzle assembly. A heavy cylinder D on the piston is made to rise by means of explosion in its head and, on falling, its base strikes the anvil and produces the hammer blow for driving the pile. The cylinder is guided throughout its fall by the

piston and piston-rod, and the anvil is slidably fastened to the supporting mast. When the cylinder strikes the anvil a ring E round its base strikes a lever F, which actuates the injection pump G to supply a fresh charge of fuel up through the piston-rod to the combustion chamber. As the cylinder rises the piston exposes ports in its wall through which the combustion gases are exhausted and clean air introduced. In order to prevent the whole machine rising off the pile during the last stages of the upward movement of the cylinder, a wedge H having a ratchet action holds the base to

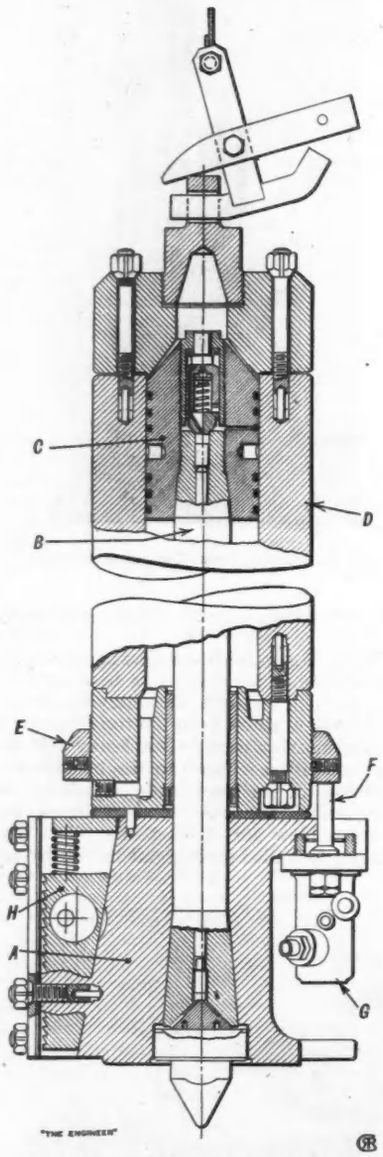


FIG. 9—DIESEL PILE DRIVER—LAGONDA

restrict upward motion but permit free downward motion.

This power unit, which is cold starting and operates on any commercial quality diesel or gas oil, is just over 3ft 3in high and weighs only 323 lb. Its fuel consumption is stated to be 0·7 pint per hour. It transmits 300 blows per minute to a pile, the kinetic energy per stroke being 1178ft-lb.

Equipment supplied with the unit for pile driving includes a light portable 27ft mast and a winch for raising the piles and lifting and starting the power unit. The outfit is suitable for steel sheet piling, timber and concrete up to 20ft long. No section of the mast exceeds 14ft in length and it can be easily manhandled, the total weight with mast and all accessories being under 15 cwt.

The vertical leader, or guide, of the mast is a selected R.S.J. joined midway. This carries the pulley head gear in "hammer" fashion ensuring an even load distribution. A 1-ton direct lift all-steel hand winch with machine-cut gears is capable of accommodating 70ft of 1in circumference 6/19 steel wire hoisting rope. The foot of the mast is hinged at the base on a steel pin, and it is held in position by a tubular back stay allowing for front and back rake. Side stability of the mast is obtained from steel guide ropes with rigging screws for tension. It can be assembled in a horizontal plane and then erected. The mast and pile-driver are protected against corrosion, and the unit is claimed to be impervious to occasional submersion in water.

B. Johnson and Son

The "Benjo" power rammer made by B. Johnson and Son, of Skipton Road, Ilkley,

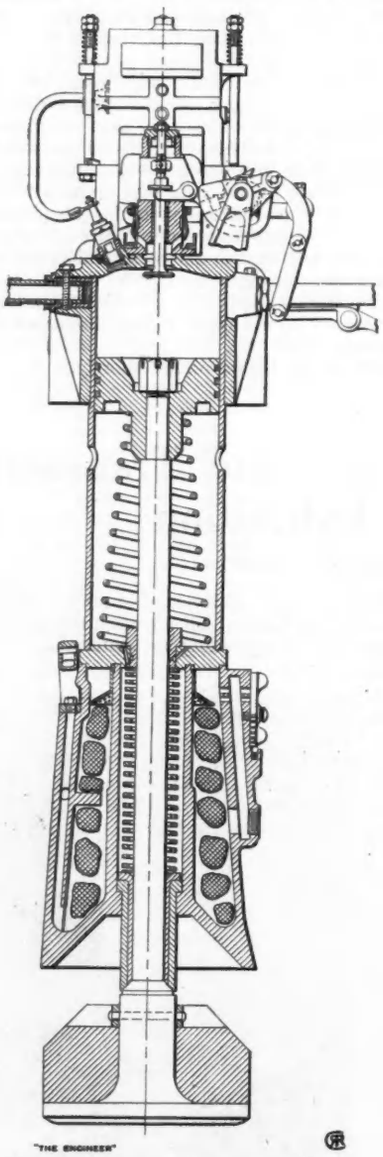


FIG. 10—POWER RAMMER—JOHNSON

Yorkshire, was exhibited with two types of foot, the standard type, 9½in diameter and one with a 7½in diameter foot for narrow trench work. Both types of rammer are identical and their design can be seen in the drawing we reproduce in Fig. 10.

The machine base consists of a casting, the bottom half of which serves as a petrol tank and the upper portion as a surface type carburettor. In operation gas is drawn from the upper part of the base, through two tubes at the side of the machine, into the cylinder head. The mixture is exploded by a spark from a magneto actuated by a lever on the operating handle. The explosion forces the piston down and causes the machine to jump vertically into the air. As the piston passes exhaust ports in the cylinder wall downward movement of the machine takes place. On the foot striking the ground the body of the machine follows through and gives a secondary blow on a rubber block set on the top of the foot. The second blow brings the piston within an inch of the cylinder head and serves to thoroughly scavenge the cylinder. A spring returns the body of the machine to its normal position in relation to the piston-rod and foot assembly. This movement draws the piston away from the cylinder head, thus creating suction to draw gas from the base preparatory for the next working jump.

To prime or start the machine the operator presses down on the two handles, forcing the body of the machine into contact with the rubber block. The movement compresses the spring, which, on return to its normal position, provides the suction stroke for the first charge.

J. Dawson Fawcett (Darlington), Ltd.

A tarmacadam mixer with a capacity of 42 cubic feet per batch and which is designed for heating by electrical means was to be seen upon the stand of J. Dawson Fawcett (Darlington), Ltd., Haughton Engineering Works, Darlington. The end plates and mild steel extended side plates of the mixer are lined with renewable manganese steel liners up to mixing level. Manganese steel tips are also fitted to the cast steel mixer arms and to the end arms. A fully balanced outlet door is fitted with a quick-action, self-locking lever motion, and is designed to open the full width of the mixer to give quick and complete delivery of its contents. Electric heating elements are provided on the end plates and four special plates serve to heat the bottom of the mixer. Heating elements are also fitted to the tilting measuring tank, which is designed to spread its contents evenly over the full width of the mixer.

The machine can be worked as a heated or non-heated unit according to requirements, and is provided with a deflection plate, fitted with a renewable liner, for directing its contents into a travelling weigh hopper.

The weigh hopper is fitted with renewable steel plate liners and has a balanced, quick-acting, hand-operated outlet door. The weight of its contents is indicated on a large calibrated dial which incorporates a dashpot control and has knife-edge levers. It is mounted on four single-flanged travelling wheels and can be arranged to run on rails by the side or underneath the aggregate storage bins. An individual electric motor which drives the hopper through a worm gear-box has an automatic brake which comes into operation when the current is switched off. If required it can be used as a fixed hopper by the movement of a lever which throws the weighing gear out of action. The controller operating the unit is of the "dead-man's" handle type, and switches the current off when released.

R. A. Lister and Co., Ltd.

A replica of the track in the engine erecting shop at the main works was arranged on the stand taken by R. A. Lister and Co., Ltd.,

of Dursley. Parts sent from the works could be seen being assembled from the initial stages up to the completed engine.

A Lister-Todd insecticidal fog applicator on view is a machine designed to discharge insecticides, fungicides, repellents and hormones of selected particle size in a fog which quickly surrounds and clings to all objects.

The principle upon which the apparatus works can be followed with reference to the diagram, Fig. 11.

Petrol for the engine A and the burner in the combustion chamber B is drawn from the petrol tank in the base of the machine by a petrol pump C. From the pump the petrol passes through a regulator valve which divides the flow so that a portion is metered to the burner in the combustion chamber, while the remainder passes to an engine gravity tank which supplies the engine. From this gravity tank surplus petrol returns to the main tank.

Petrol is supplied to the burner under a pressure of 40 lb per square inch, and is atomised by a burner tip inside the combustion chamber. The combustion chamber is supplied with air by a blower D. This air passes through a stainless steel diffuser which causes it to cool the shell of the combustion chamber. At the same time the centre of the chamber is maintained at its maximum and most efficient temperature at 2700 deg. Fah.

The mixture is ignited in the chamber by a sparking plug which is constantly sparking while the machine is running. Combustion causes a rapid expansion of gas which leaves the chamber under pressure and provides the air blast at the distributor head E.

The liquid to be fogged is drawn by suction by a pump F from a container G. It passes from the pump through a formulation pressure-control valve H, which controls the pressure of the liquid to 25 lb per square inch by by-passing the surplus liquid back to the container. This method of by-passing and return maintains the suspension or solution in a state of agitation. Liquid not by-passed continues through a quality-control valve J which controls the particle size by reducing the flow of liquid. This valve, when the machine is using a large particle size (30–60 micron), passes 40 gallons per hour, whilst when a small particle size (10–20 micron) is used only 15 gallons per hour pass through the valve. The liquid then passes through the fog supply remote control valve K and on to the insecticide nozzle in the distributor head.

This nozzle delivers the insecticide through four holes into a mirror-finished stainless steel cup. This cup is drilled with four tangential holes through which a small portion of the hot air blast from the combustion chamber passes to impart a swirling motion and vaporise the insecticide. Vaporisation is assisted by the heated cup, and finalised when the already partly fractionised insecticide vapour meets the main air blast. The temperature of the air blast at the distributor head is 900 deg. Fah., but as the insecticide is only in contact with it for a fraction of time, the insecticide does not suffer any ill-effect.

The same liquid can be dispersed as a spray if the burner valve is not turned on, when the liquid particles proceeding from the nozzle are not broken down further due to the absence of vaporising heat. The cold air blast is of sufficient force to operate the machine as a spray.

The single standard distributor head can be substituted by double or triple heads for specialised work.

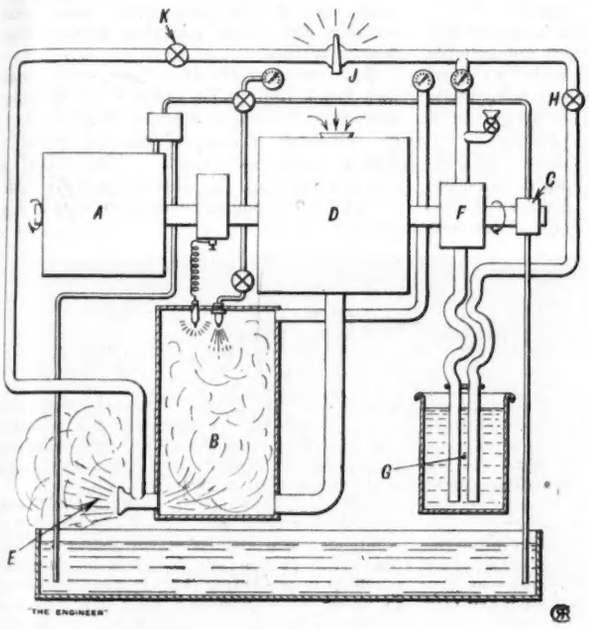


FIG. 11—FOG APPLICATOR—LISTER-TODD

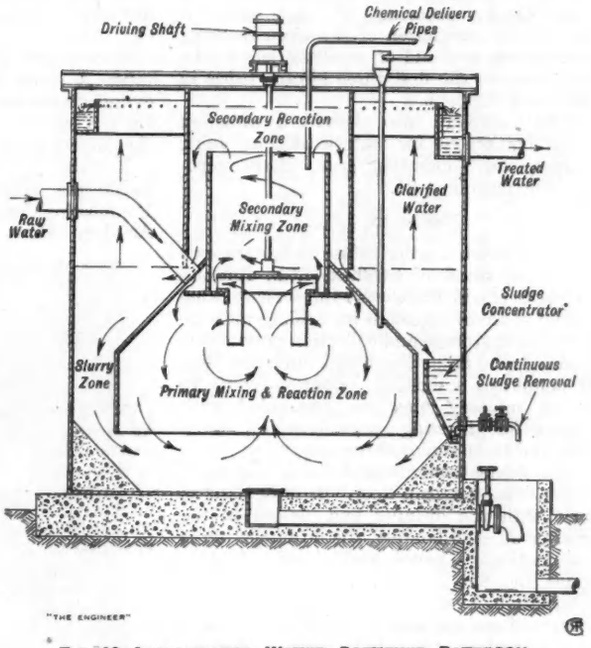


FIG. 12—ACCELERATED WATER SOFTENER—PATERSON

PATERSON ENGINEERING COMPANY, LTD.

Included in the range of water-treatment plant on the stand of the Paterson Engineering Company, Ltd., Windsor House, Kingsway, London, W.C.2, was the firm's latest design "Accelator" softener or clarifier. With this process, a diagram of which is reproduced in Fig. 12, the retention capacity of reaction tanks is reduced to about one hour. The principle of this accelerated process lies in intimately mixing preformed slurry with the measured quantity of chemical reagents and the water to be treated. It is characterised by intensive mixing between slurry, purifying chemicals and water which are circulated about three times within the apparatus before the clarified or softened water separates by upward flow from the slurry bed to the plant outlet.

The company has also arranged a demonstration of a dry feeder, suitable for measuring such reagents as sulphate of alumina, lime, chalk, or activated carbon, &c. It may be operated by electric or water power, and can, with additional equipment, automatically proportion the dose of reagent to a varying flow of water or other liquid.

GLENFIELD AND KENNEDY, LTD.

The "Peebles" machine for washing filter-bed sand is made by Glenfield and Kennedy, Ltd., Kilmarnock, in three sizes to deal with 4, 8 and 12 tons of sand per hour. These machines are built in portable and fixed types, and the portable 4-ton machine to be seen in Fig. 13 was exhibited by the company.

This machine operates on a partial contra-flow principle, the sand against the water. Dirty sand is fed into an elevated hopper at the front, whence it is ejected hydraulically on to an oscillating screen. This screen

FIG. 13—PORTABLE SAND WASHER—GLENFIELD AND KENNEDY

removes any large stones or lumps and the graded material drops through it into the first of a series of hoppers. In the hopper scouring jets remove the dirt as the sand drops to the bottom, where hydraulic ejectors discharge it into the next compartment, where the scouring process is repeated. The sand passes through five hoppers, and is finally discharged hydraulically on to a heap or into trucks.

Wash water economy is obtained by passing a proportion of the flow through each of the lower four hoppers in turn, the cleanest water being in the final hopper, where the sand enters in the cleanest condition. Efficient high-velocity scouring of the sand is ensured by the action of the main scouring and ejector jets and of auxiliary jets at the entrances to the first three ejector tubes in the lower hoppers.

This company also showed a range of other equipment for waterworks, including valves, valve-operating gear, filters, pipe-cleaning machines, &c.

Shefflex Ltd.

In addition to the refuse collectors seen upon the stand of Shefflex, Ltd., Rutland Street, Sheffield, there was a full-scale working model of an arrangement for dealing with the problem of storage and collection of domestic refuse from flats, tenements and the like. It comprises a dustless, odourless chute in which sanitary bins are suspended with means for hoisting and lowering when required to be removed for emptying.

The model demonstrated the arrangement to be fitted on each floor. It is devised so that with the opening and closing of the shutter on each landing, the lid of the bin is automatically opened and closed. It provides for flat and tenement dwellers an alternative system to the ordinary bin system of storage and collection and disposes of the need for the refuse chute, container, container house, and costly transport system for collecting and emptying containers.

The refuse can be collected with the ordinary refuse vehicle, the whole arrangement on all floors being locked by a simple method whilst this is effected. The system eliminates risk of fire, dust, foul smells, &c.

Some Other Exhibitors

The Expanded Metal Company, Ltd., Burwood House, Caxton Street, London, S.W.1, exhibited a representative range of its well-known expanded metal products. A recent addition to this range is "X.P.M." welded wire fabric for concrete road-making, which is supplied in flat sheets up to 17ft long and 8ft wide, and in certain sizes in rolls up to 150ft in length.

Exhibits on the stand of Bell Brothers (Manchester 1927), Ltd., Denton, Manchester, the makers of water-purification, softening and sterilisation equipment, included three models of different types of filters. Another exhibit was a control table, equipped with Lockheed control gear, for operation of valves on either pressure or gravity filters; the table is also fitted with manometers, flow recorders, pressure gauges and sample taps. A sluice valve fitted with Lockheed cylinder was also shown, provision being made for the operation of the valve by means of the control table as in actual practice.

Together with its other types of reinforcement, the Johnson's Reinforced Concrete Engineering Company, Ltd., Artillery House, Artillery Row, London, E.C.1, showed the "Benfix" prefabricated lattice beam. This beam is designed to replace timber joists in houses and general flooring work. Its open web construction enables service pipes, electric conduits, &c., to be accommodated without cutting. It is simple to handle and easy to fix, and is claimed to form a standard method of construction.

The Dover Engineering Company, Ltd., St. Stephen's House, Westminster, S.W.1, exhibited a comprehensive selection of its "Elkington-Gatic" watertight and non-rocking covers for manholes, trenches, and road work. They included sections of duct covers housing various fillings, multiple, single and double-span covers and frames suitable for roads carrying heavy, fast-moving traffic.

To demonstrate the now well-known fork truck and pallet method of handling materials, Coventry Climax Engines Ltd., of Coventry, displayed on its stand a 4000 lb capacity truck. This truck is powered by one of the company's four-cylinder petrol engines which develops 27 h.p. at 2400 r.p.m.

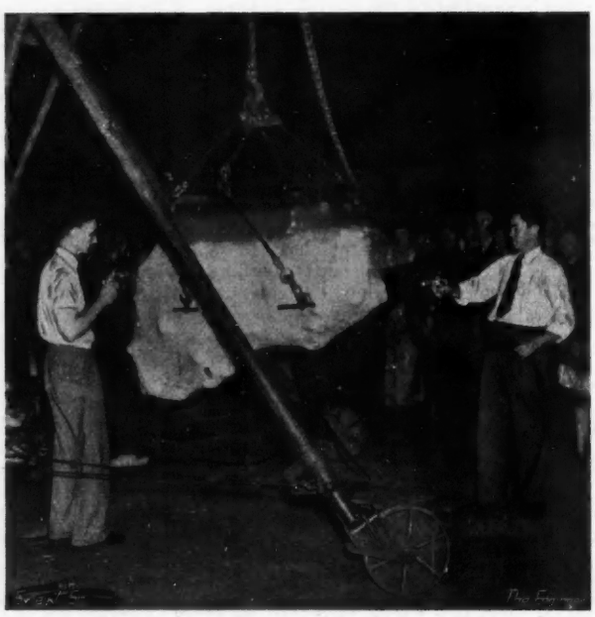
Cocoon Packaging

ON Friday of last week, July 25th, we were invited by the Ministry of Supply to attend a demonstration and trial, the first of its kind in this country, of the new "Cocoon" process of packaging by means of applying plastic webbing and coatings. It took place at the No. 9 Maintenance Unit at the Royal Air Force Station at Cosford, near Wolverhampton. The demonstration was made on several pieces of equipment which had been submitted by the Admiralty, the War Office and the Air Ministry, and it was attended by many officers of the Forces, and by representatives of the Ministry of Supply and industrial interests.

The process was invented and developed in the United States by Mr. Ed. J. Butler, president of the Butler Corporation, Inc., of Philadelphia, Pa., and his associate, Mr. Russell Hursum. Through the enterprise of R. A. Brand and Co., Ltd., the paper and paper-converting merchants, of Pendleton, Manchester, and Ormonde House, St. James's Street, London, S.W., the "Cocoon" process has been made available for this country and for Europe. Among those who attended were the inventor and his associate, and Mr. H. H. Brand and Mr. J. L. Kennett, the managing director and general manager respectively of R. A. Brand and Co., Ltd.

The process embodies a novel and ingenious idea of packaging all kinds of machinery and equipment in a manner which resists rust and corrosion. It has been found to be especially valuable in protecting for shipment or storage for short or long periods Service armament and equipment, machine tools, electrical apparatus, refrigerating machinery, washing machines, and farm implements. It was employed, we may recall, by the United States Naval Authorities, for laying up the surplus part of the American Fleet after the end of the war, and has been widely used both in America and in Alaska. The United States Navy believes that the equipment so preserved will be in such a state as to render it fit for immediate service should an emergency occur.

In our issue of February 14, 1947, our naval correspondent, the late Commander Kenneth



Applying Webbing Film to Director Gear and Coatings to "Merlin" Engine

Edwards, R.N. (Ret.), gave a fully illustrated account of the method employed in his article on "Laying up the American Navy."

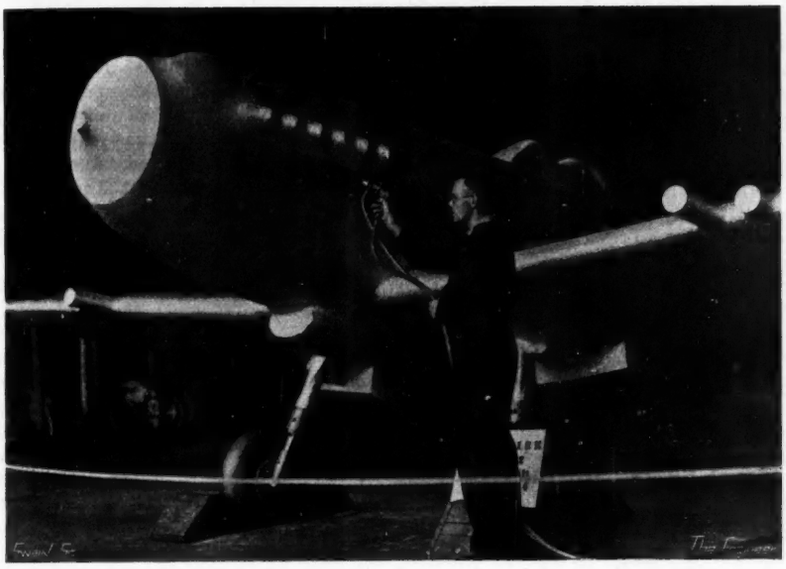
It can now be stated that "Cocoon" is a new packaging plastic which is based on modified film-forming resins, which are carried in volatile solvents. The application of the coverings using a standard British pressure gun, calls for no special technical skill, as was shown by the successful demonstration of the spraying technique, given by members of the Brand staff after brief instruction under the direction of Mr. Russell Hursum.

The first steps in the process were demonstrated on the naval director gear illustrated opposite. A wooden skid forms the foundation, and it is fitted with a metal rim to which the covering is finally sealed. Any prominent projections are first padded with rag and paper, which is held in position with tape. The framework for the subsequent coatings is provided by applying vertically and horizontally strips of pressure-sensitive tape, about 1in in width, known in the paper trade as "Scotch tape." This forms a lattice of tapes in squares of from 16in to 20in. For the first application the "Cocoon" solution is mixed with a webbing agent which produces a web-like filament, not unlike a cobweb, but of greater strength. The strands of the web as delivered from the spray gun nozzle do not pass through the lattice, but form a bridge over the squares of tape. The pressure of the spray is then altered to form a translucent film, covering the entire object, on which the later coatings are sprayed. It is usual to spray two further coats of "Cocoon" solution, which we noted are distinguished from each other by mixing with the solution a small percentage of dye. White, red, yellow and blue are the colours most frequently used, and to assist the operators a multi-cell pressure tank is employed, with stirring gear, so that any desired colour of coating can be applied quickly. The number and types of coatings depend on the duration and conditions of the storage period, and for a long storage a third finishing coat is given. Periods of storage from a few months up to ten and twenty years can be catered for.

In order to demonstrate the various stages in the process after the director gear had been covered with web filament, a "Merlin" aero-engine, which had previously been sprayed with a white coating, was given two successive coatings of yellow and red. The finishing process of applying a black bituminous coating in order to resist weather was shown on a receiving set which had already received its red coating, while a 6-pounder quick-firing gun, already sprayed with the bitumastic coating, was given an aluminium finishing coat like that which had already been applied to the "Spitfire," shown in the accompanying engraving. The aluminium coating reflects infra-red rays and tends to keep the enclosed equipment cooler in hot sun.

Some particulars of the covering capacities of the sprays are of interest. One gallon of the webbing solution is sufficient to cover about 100 square feet of surface, and the coating solutions have a similar coverage for a thickness of about 4·25mils. The tensile strength of a completed covering has been recorded as between 1750 lb and 2000 lb per square inch. Solutions can be applied at any temperature between 40 deg. and 120 deg. Fah., and they are only inflammable during the spraying operation.

Should it be desired to remove the solvent vapours from the enclosed object, a vent is cut in the envelope, and warm air is injected at a lower vent. Afterwards a suitable drying material such as silica-gel, can be introduced with or without an indicator for showing damp, and the openings can be closed again by patching with the identical cut-out pieces. Finally, the "Cocoon" envelope formed is carefully sealed to the metal rim. If desired, a "Vinalite" inspection window can be fitted in the enclosing covering.



APPLYING ALUMINIUM FINISHING COATING TO "SPITFIRE"

Before leaving the Cosford R.A.F. Station, visitors were permitted to see a training film prepared by the United States Navy which dealt with the method of applying the "Cocoon" coverings, the distances of the spray gun for the different coatings, and the air pressures employed.

We learn with interest that R. A. Brand and Co., Ltd., will be able to provide a very large percentage of the raw materials necessary for making up the "Cocoon" solutions, and that British spray guns, nozzles, and pressure tanks can be employed.

D.S.I.R. Chemical Research Laboratory

IN connection with the Chemical Society's Centenary Celebrations and International Congress of Pure and Applied Chemistry, an opportunity was taken to open for inspection, last week, the chemical research laboratory of the Department of Scientific and Industrial Research at Teddington. This laboratory does not usually take part in the open day of the National Physical Laboratory. But it is associated with the N.P.L. as part of the D.S.I.R. under the executive control of the Director, Professor, R. P. Linstead, and his assistant, Dr. D. D. Pratt, who acted as laboratory superintendent from 1942 to 1945. Previous Directors were Sir Richard Threfall, Sir Gilbert Morgan and Dr. G. S. Whitby.

The laboratory was founded in 1925 and was accommodated in a building begun in 1924 on a site near to the National Physical Laboratory. It brought together in one laboratory the work on chemical research which was previously carried out in various establishments by isolated groups of workers. Up to 1933 the laboratories were extended from time to time until the present buildings were in existence. In 1946 and 1947 various alterations were made and an additional temporary building was added. The Chemistry Research Board is responsible for advising the Department on the programme of work of the laboratory, and the present Chairman of the Board is Sir Norman Haworth, F.R.S. The heads of various sections are:—Dr. W. H. J. Vernon, corrosion of metals; Dr. G. R. Davies, inorganic; Dr. E. A. Coulson, coal tar; Dr. D. V. N. Hardy, organic intermediates; Dr. K. W. Pepper, high polymers and plastics; Dr. J. G. Mitchell, information services; and Mr. V. A. Yardley, A.M.I. Mech. E., engineering services. The total staff now exceeds a hundred workers.

The buildings contain sixty-five rooms of various sizes, of which nineteen are normal research laboratories and fourteen specialist laboratories. These latter include three semi-scale laboratories, one for general purposes, one for plastics, and one for high-pressure work. Besides various rooms set apart for special apparatus, are a drawing-office, two well-equipped engineering workshops and a glass-working department. Compressed air and gas storage installations form part of the equipment and there is a working library and central administrative offices.

A record of the war activities of the laboratory is in preparation. Excellent wartime work was done on metal corrosion and plastics for Service Departments and Ministries.

The present programme includes further work on the corrosion of metals, both ferrous and non-ferrous, for industrial use, and an investigation of the micro-biological corrosion of metal, particularly in soil, by the influence of sulphate reducing bacteria. In the inorganic section the investigation of methods for the concentration or isolation of valuable minor constituents from wastes and low-grade sources is being continued, and physical methods of analysis and micro-analytical methods studied. In the plastics section the determination of the relations between the structure and the properties of high polymers and plastics is being studied and the problems connected with the preparation of improved plastic materials, such as glues and ion exchange resins.

In the coal tar section of the laboratory work is being done on the isolation and identification of tar constituents, the determination of their physical and physico-chemical constants and the development of new uses for tar products and their derivatives. The organic intermediates section is concerned with developing the technique of high-pressure operations and the study of the production of useful chemicals by such operations as the condensation of carbon monoxide with organic substances, catalytic hydrogenation, &c. Further, the preparation of compounds capable of polymerisation or co-polymerisation, including those containing silicon, is being examined. For this purpose the engineering department has designed and constructed high-pressure autoclaves of various capacities with stirring gear, for working at pressures of 250 atmospheres and temperatures up to 425 deg. Cent.

The engineering department of the laboratory also displayed the "Dirshel" still for making fresh water from sea water, which it developed during the war, along with gas flow meters and examples of the cone and ball type of joint which it has found suitable for this high-pressure work. Some examples of special jets for projecting fire-fighting foam on a target and measuring the flow of foam were also shown.

THE ENGINEER

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

DEATH

ON July 26th, E. W. L. GARDNER, director of Norris, Henty and Gardner, Ltd., Patricroft, Manchester.

COMPULSION

As a consequence of experience of load-shedding last winter few now doubt the necessity for spreading next winter's electricity load if the productivity of industry is not to suffer a severe check. Nor is anyone in doubt as to the causes of the present shortage of electrical generating plant. According to figures published by the Electricity Sub-Committee of the Joint Consultative Committee, consumption, even under the handicap of load-shedding at peak periods, has been rising since 1945 at a rate of increase of about 10 per cent per year, while the present demand is about 70 per cent above that of 1939. Nor, unfortunately, is there any hope of substantial relief during the coming winter through the bringing into operation of much new generating plant. The need to stagger working hours and so spread the load more evenly over day and night is thus so obvious as to prove convincing to all parties. Indeed, the urgent recommendation of the Joint Consultative Committee upon which the Government acted in deciding to impose compulsion indicates clearly that such a measure was felt to be necessary by both sides of industry. Yet we think the question may well be asked whether a sense of the national urgency of ensuring that hours of work are staggered is necessarily a justification of the wisdom of assuming compulsory powers.

The work of the Regional Boards and their subsidiaries in completing what Mr. Isaacs has termed "the complicated but vital task of working out plans to achieve the regional target of saving one-third of the peak load outside the daytime period" is beset with intractable problems. Labour being in short supply it seems unlikely that many factories could work two fully-manned shifts per day even if the processes involved permitted it. But to what extent will it prove possible, without imposing an intolerable strain upon management and organisation to work two partially-manned shifts? In many areas, of course, the need to solve that problem will be evaded by the arrangement of a rota system of double-shift working. But even the organisation of such a system whereby pairs or groups of factories alternately work a single early or late shift without undue overlapping involves an immense amount of negotiation and discussion with and amongst the individual firms concerned. Moreover, its success depends, too, upon the willing co-operation of workers called upon to rise at an unpleasantly early hour in the dark of a cold winter morning, to return home from work late at night, or, since some night-shift working will clearly be essential, to turn night into day. The recent agreement upon rates of pay between employers and the shipbuilding and engineering unions arouses hopes that similar agreements will be devised to facilitate staggering of hours in other industries. But what will be the effect upon the output of labour of working at unusual hours? Will absenteeism increase? It remains to be discovered, too, despite any agreements that may be reached between employers and unions, both of which are fully convinced of the urgency of the situation, whether any considerable number of workers will raise serious objections to working such hours. Nor can the effect of staggering upon the work of staffs be wholly neglected. There can be no doubt that they will loyally abide by any decisions that are made about their hours of work. But what are those hours to be? Can they be allowed to fall far out of correlation with those in the works? How, in those factories where two-shift working proves practicable, is the presence of adequate numbers of the staff and of junior executives to be ensured over a double-length day? There is the question, too, of the preservation in strange circumstances of those invaluable personal relationships that have been built up between members of the staffs of independent firms that do much business together. Is there not a danger that they may be lost when the firms concerned happen to be placed on opposite sides of the staggered rota? There are so many such problems and so many scarcely ponderable considerations to be taken into account in planning staggered hours that only willing co-operation amongst all concerned, the Regional Boards and their district committees, individual firms and their managements, the unions, and, not least, the workpeople themselves, can possibly make a staggered system of working hours operable in a reasonably satisfactory manner.

No doubt it is because, in a matter of such complexity, the refusal of co-operation by a single recalcitrant firm or group of workpeople might endanger the success of a staggered hours system in a whole area that the Government has become convinced of the need for compulsory powers. Yet though on that very ground we feel reluctantly compelled to admit that the Regional Boards need to be equipped with some means for compulsion, the possession of such powers undoubtedly lays a heavy responsibility upon the Boards. Were persuasion their only weapon it would be essential for them to give very careful consideration to the submissions of any firms which believed themselves unfairly treated by any schemes proposed. It is, indeed, conceivable under such circumstances that a Board or one of its committees originally acting the *rôle* of persuader might in the outcome become the persuaded. But in similar circumstances a Board having compulsory powers may be tempted, out of impatience or lack of sympathy, to make use of them to overcome opposition, which was deemed, too readily, to be unreasonable. Nor does the provision that penalties cannot be applied until the Board concerned, the Electricity Sub-Committee, and the Minister himself, are all satisfied as to the need wholly relieve the situation. For only the district committee of the Board concerned is likely to be fully familiar with all the matters at issue and their relevance to local conditions, whilst the other bodies are, to some extent at least, parties interested rather to ensure that any propounded scheme operates than to consider the complaints, relatively petty to them, of individual concerns. We, therefore, very heartily support Mr. Isaacs' hope that "such powers will be required only very exceptionally." For any attempt to use them at all extensively must, we believe, necessarily lead to the breakdown of that general and willing co-operation in every district without which no scheme for staggering hours of work can be expected to operate successfully.

RESEARCH AND PRACTICE

FROM the very moment when it first came into power our present Government pressed upon industry the importance of research work. No doubt members of the Government had been impressed by the rapidity with which technical advances were made during the war, often as the direct consequence of intensive research. Manufacturers and industry at large have not proved at all unwilling to take advantage of this encouragement, backed, as it is, by certain financial incentives. For though twenty years ago research associations and other bodies often found it difficult to raise sufficient funds (partly, no doubt, because in that depressing period between the wars firms were often hard put to it to earn any profits and had little money to spare to finance projects offering no immediate hope of return), the attitude of industry has now altered. Our pages bear witness to that change. Quite recently, for instance, we have described and illustrated the

Thornton Aero-Engine Research Laboratory, to which a new wing has been added, a steel foundry laboratory erected by Kryn and Lahy, Ltd., and the buildings of the Fulmer Research Institute. Early this month the Sketty Hall laboratories of the British Iron and Steel Research Association were opened. Moreover, the extension or rebuilding of other laboratories is projected. No doubt, for example, the British Electrical and Allied Industries Research Association will soon be appealing to its members for funds with which to make a beginning on the erection of new laboratories at Leatherhead, plans for which are already drawn up. Towards all such projects the Government exhibits itself in its more paternal and sympathetic mood, as, for instance, when it accepted from Mr. Palmer amendments to the Electricity Bill designed to clear the way for supply companies, in the interim before being taken over under the nationalisation scheme, to make contributions to research organisations.

It is true that in the past, as Dr. Bailey pointed out in a lecture at Leicester College of Art and Technology that we abstracted in our last issue, "a disparaging attitude against technical knowledge beyond a rudimentary order has sometimes been exhibited by ultra-practical men." But the pendulum seems now to have swung the other way, and the encouragement of research is commended upon every hand. So that, whilst, undoubtedly, welcoming the present flowering of interest in research, we still sometimes feel inclined to wonder how it is to be kept under some proper control. In his recent inaugural lecture as Professor of the History and Philosophy of Science at University College, London, Professor Herbert Dingle asked how it came about that "a generation so amazingly proficient in the practice of science can be so amazingly impotent in the understanding of it," and remarked later that "men of science . . . have been satisfied for the most part to be obviously doing something without caring to define, even to themselves, what their activity means." He pleaded for "a critical school, working within the scientific movement itself and performing the function, or at least one of the functions, which criticism has performed for literature from the earliest times." The characteristics of pure science to which no doubt Professor Dingle particularly referred are, of course, somewhat different to those of applied science. But even in the limited field of engineering fundamental research work is usually carried out upon lines closely similar to those adopted for pure science researches. In fact, all research organisations, even engineering ones, are, we believe, open to the danger of becoming "satisfied to be obviously doing something . . . . without caring to define . . . what that activity means." The counter is adequate, informed and continuously maintained criticism. It must come, not from such ultra-practical men as those to whom Dr. Bailey referred, for they often mistake the nature and value of fundamental research, but from professional engineers adequately trained, not only to appreciate the meaning of fundamental discoveries, but to see also whether or not they are likely to be applicable to practice. Are we producing such men?

Just because engineering is applied science, with the defined object of "directing the great sources of power in Nature for the use and convenience of man," there is a need amongst the ranks of professional engineers for many men, well equipped, theoretically and practically, to provide that "critical school working within the movement itself" for which Professor Dingle pleads. Yet, in observing that in our universities and technical colleges the training is such as to provide a higher regard for theoretical than practical knowledge and noticing, too, the trend amongst technical institutions towards insisting upon high academic attainments before admitting young men to membership many may have wondered whether the need for counterbalancing "down-to-earth" practical knowledge is beginning to be neglected. The corrective to any such line of thought is, we think, to be found in the report issued by the Institution of Electrical Engineers about a fortnight ago upon "The Practical Training of Professional Engineers." In that document a successful attempt is made to lay down the objects of a training scheme, to suggest a syllabus and to recommend suitable means of organisation and supervision; in brief, to set up a standard of practical training. Nor, though it is perhaps somewhat in this matter in advance of others, is the Institution of Electrical Engineers alone in giving its attention to schemes of practical training. In the great symposium of papers on the education of engineers, held by the Institution of Mechanical Engineers in 1943, for instance, the authors and many of those who took part in the discussion directed attention to the same point. Moreover, many individual firms, civil, mechanical and electrical, have developed, and are developing, carefully worked out schemes for the practical training of engineers. This interest now being taken by institutions and engineering firms in the more carefully arranged practical training of young men can, we think, be all the more heartily welcomed, because it comes at a time when research organisations are multiplying. For only engineers as carefully and critically trained in the practice of their profession, as in its theory, will be adequately equipped mentally both to appreciate and, when necessary, to criticise the work of research bodies; and to decide whether and how the results of research can be applied to the practical business of design and production.

Obituary

A. P. TROTTER

THE older generation of engineers in particular will have learned with regret of the death of Mr. Alexander Pelham Trotter, which occurred at his home at Teffont Ewyas, Salisbury, on July 23rd. In the course of a long and active life, he made many valuable contributions to the science and practice of electrical engineering. Furthermore, he was a well-known authority on illumination.

Alexander Pelham Trotter was born at Woodford, Essex, in 1857, and was educated at Harrow and at Trinity College, Cambridge, where he gained a Natural Science Tripos. It was during his time at Cambridge that he made the initial calculations which led to his prismatic glass invention. That invention was patented in 1881, and the glass was exhibited at the Crystal Palace Exhibition in 1882. Mr. Trotter served an apprenticeship with Easton and Anderson, a firm then established at Erith. From 1883 to 1887 he was a partner in the firm of Goolden and Trotter, dynamo manufacturers, of Halifax, and later on, in 1890, became Editor of our contemporary, *The Electrician*, a position which he occupied until 1895. In the following year, Mr. Trotter went to the Cape of Good Hope, where for three years he served as Government electrician, and upon his return to this country in 1899, he was appointed electrical adviser to the Board of Trade. He relinquished that position in 1917, and for a few years subsequently he was in partnership with Messrs. Handcock and Dykes, consulting engineers, in Westminster. He retired to Teffont Ewyas, near Salisbury, in 1920.

For many years, Mr. Trotter took an active part in the work of several scientific institutions and societies. He was a member of the Institution of Civil Engineers and the Institution of Electrical Engineers, a Fellow of the Physical Society, and a Past-President of the Illuminating Engineering Society. His contributions to the proceedings of those societies included papers on "Measurement and Distribution" and "The Construction of Overhead Electric Lines," for which he was awarded the Telford Medal and Premium of the Institution of Civil Engineers. Mr. Trotter was also Faraday Lecturer in 1926 to the Institution of Electrical Engineers, his subject for the occasion being "Illumination and Light." Amongst his other published works were two books on "Illumination: Its Distribution and Measurement" and "The Elements of Illuminating Engineering."

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SCIENCE, LIBERTY AND PEACE

SIR,—For the last 100 years what Mr. Felton calls "the victims of industrialisation" have had the majority of votes and if they have not obtained the economic results they desire that is not due (as he suggests) to "the mass application of applied science," but rather to the misapplication of political slogans.

Thus we have become dependent on imported food for our existence, and are trying to pay by artificially stimulated exports; in short, by forced sales.

Mr. Felton blames "the struggle for higher production," but what is really going on is a struggle for less work coupled with a demand for more supplies from the food-producing countries. I find it difficult to understand what Mr. Felton means by or expects from "democratic ideals," but I believe that we might yet find salvation by the mass application of applied science (and capital) to agriculture, thus increasing home food production; and by treating the farming and peasant population as having equal rights to the urbanites. Unfortunately, urban organisation and votes are predominant in the state and the importance of giving value for value received is overlooked. We are having a painful and expensive re-education, and are warned by authorities who should know that it will get worse before it gets better.

F. L. WATSON

Lyndhurst, Hants, July 20th.

Lloyd's Register Shipbuilding Returns

The statistics issued by Lloyd's Register of Shipping regarding Merchant Vessels under construction at the end of June last, show that in Great Britain and Ireland there was an increase of 31,234 tons in the work in hand as compared with the figures for the previous quarter. The present total of 2,062,949 tons gross is also greater by 298,006 tons than the tonnage which was being built at the end of June, 1946, and has not been exceeded since March, 1922, when the total recorded was 2,235,998 tons. At the end of June the tonnage on which work was suspended amounted to 4136 tons. The tonnage intended for registration abroad or for sale rose progressively during 1946 from 105,000 tons at the end of March to 248,000 tons at the end of June, to 387,000 tons at the end of September, and to 478,000 tons at the end of December. The figure of 513,000 tons noted at the end of March of this year has now risen to 580,000 tons, or 28·1 per cent of the tonnage being built in this country. The tonnage of Merchant vessels under construction abroad at the end of June is shown as 1,783,707 tons gross, which is 72,107 tons more than that recorded at the end of March last. Returns have since been received in respect of Poland, including Danzig, and the figures for France are now considered to be comprehensive. The leading countries abroad are: Sweden, 266,905 tons; France, 236,678 tons; Holland, 224,428 tons; British Dominions, &c., 221,494 tons, including Canada, 161,160 tons; Italy, 191,342 tons; United States of America, 183,236 tons; Denmark, 139,992 tons, and Spain, 112,524 tons. The total tonnage under construction in the world amounts to 3,846,656 tons gross, of which 53.6 per cent is being built in Great Britain and Ireland, and 46.4 per cent abroad. During the quarter under review, in Great Britain and Ireland, 272,703 tons were begun and 243,644 tons were launched. Similar figures for abroad are 246,283 tons begun and 322,067 tons launched. Steam and motor oil tankers of 1000 tons gross and upwards under construction in the world amount to 69 vessels of 616,785 tons (14 steamers of 119,192 tons, and 55 motorships of 497,593 tons). Of these, 36 vessels of 323,110 tons are being built in Great Britain and Ireland, 9 vessels of 102,200 tons in Sweden, 6 of 51,520 tons in France, and 4 of 47,936 tons in Denmark. Of the total under construction in Great Britain and Ireland at the end of June, 1,011,153 tons consisted of steamers and 1,043,223 tons of motorships, while at the same date the tonnage being constructed abroad comprised 535,600 tons of steamers and 1,248,107 tons of motorships. The vessels being built in the world at the end of June include 39 steamers and 69 motorships of between 6000 and 8000 tons each; 21 steamers and 61 motorships of between 8000 and 10,000 tons each; 29 steamers and 37 motorships of between 10,000 and 20,000 tons, and 6 steamers and 2 motorships of from 20,000 to 30,000 tons. Tonnage to Lloyd's Register Class: At the end of June, 2,419,823 tons, nearly 63 per cent of the merchant shipbuilding in hand throughout the world, are being built under the inspection of Lloyd's Register. Of this total, 1,713,012 tons, representing more than 83 per cent of the tonnage being built there, are under construction in Great Britain and Ireland; while of the tonnage being built abroad, 706,811 tons or nearly 40 per cent are being constructed under the inspection of Lloyd's Register.

British Industries Fair, 1948.—The Board of Trade announces that the British Industries Fair, 1948, will be held in London and Birmingham from May 3rd to 14th. Forms of application for exhibiting space will shortly be sent to manufacturers known to be interested in the Fair. On receipt of the application form, intending exhibitors are urged to notify promptly their requirements in order to facilitate the early allotment of space.

Powder Metallurgy

No. III—(*Continued from page 73, July 25th*)

WE continue our report of the Symposium by giving abstracts from the discussion on "Magnetic Powders and Products."

Discussion

Mr. W. F. Randall (Telegraph Construction and Maintenance Company, Ltd.) commented on materials used for magnetic dust cores. The only feature which they had in common with powder metallurgy is that they were made from dust, the aim being not to produce a coherent metallic mass, but to prevent that, as far as possible, by insulating the particles.

Mr. Polgreen stated in his paper that the intrinsic permeability of magnetic oxides of iron was very low, but research done on the ferrites hardly bore that out, and he thought that a permeability as high as 4000 is claimed for certain complex magnetites, containing zinc, nickel, cadmium, and copper. Mr. Polgreen dealt rather cursorily with Sendust, an alloy which was brought out in Japan, and gave its permeability as about 70. When he (Mr. Randall) knew Sendust before the war, samples of cores obtained from Japan gave a permeability of about 110. The drawbacks to that material were that it was very difficult to make a homogeneous alloy and that the optimum composition was very critical, so that it was a problem to get the material in the best condition to give high permeability. He suggested that the problem might be solved by adopting a double powder metallurgy technique, *i.e.*, starting to make the alloy from powders of iron and aluminium and, having made the alloy, which should be perfectly homogeneous, powdering it up again into the dust which is required for the core.

Dr. Pfeil, in his own paper, had brought out the pre-eminence of the carbonyl-iron in particle size and particle shape. Those factors were characteristic of the method of formation. If it were possible to make a nickel-iron with the same particle size and shape as carbonyl-iron it would lead to some very great advances. He imagined that research had been done along those lines, but did not know how far Dr. Pfeil's own company had investigated the possibility of simultaneous deposition of nickel and iron to give a carbonyl-nickel-iron. He knew that Sendust of nickel and iron had been produced in Germany and had given very much better magnetic properties than the ordinary material.

One point which was omitted from these dust core papers but which Mr. Garvin mentioned in his paper was the possibility of increasing the density of the dust core compact by grading the powders. The advantage of that process was brought out by Mr. Chesters in a paper read before this Institute. He would like to know whether any further information could be given on that subject.

Another line of research which he would like to suggest for consideration was in the heat treatment of these cores, which consisted of a mass composed of small heat-conducting particles surrounded by a heat-insulating layer. He suggested that some sort of high-frequency heating could be employed with great advantage.

When Dr. Pfeil asked whether the research in the future should be directed to diminishing the amount of diluent in these cores, it struck him that Porosint (of which photomicrographs were shown by Mr. Sinclair in his paper in Section E of the symposium) consists of spheroidal particles, and in the early stages the point of contact between those particles was very small. If it were possible to use those particles and keep the point of contact down to a very low level a very high resistance compact might be obtained. Mr. Randall then referred to one or two points on magnetic properties which arose from the papers.

Mr. Polgreen had stated that hysteresis loss was dependent upon the uniformity of the powder. He did not know whether that meant uniformity of size or uniformity of shape, and would be glad if Mr. Polgreen could expand the statement a little.

Considerable advances had been made in the permanent magnets when magnetic treatment was applied to them. Magnetic treatment could not be applied in quite the same way to the dust core, but, if it were possible when the core was being compacted to apply a magnetic field, so that all the particles were aligned in the optimum and easiest magnetic path, the hysteresis factor should be considerably reduced, because when the core was subsequently used all the flux would be flowing in the path of easiest magnetisation, which was also the path of lowest hysteresis.

In Fig. 1 (*a*) of Mr. Polgreen's paper the magnetic viscosity of various powders was shown in graphical form, magnetic viscosity being defined by Mr. Polgreen as the hysteresis loss at zero flux density. This viscosity loss was usually at a minimum when the initial permeability was highest, but there were two samples given in Table I (*a*) which have initial permeabilities in the ratio of possibly 10 or 20 to 1, yet the core with high permeability showed a much lower viscosity.

In Dr. Pfeil's paper there was a discussion on the hysteresis of mechanically hard particles. He wondered whether they were quite right in assuming that low hysteresis was associated with mechanical hardness. The induction in the hard particles would be very small compared with the induction in the soft particles, so it might be that the intrinsic hysteresis of the hard particles (as measured at a given maximum induction) was actually higher than that of the soft particles.

In these dust cores the characteristic of the powder which was of the greatest importance after particle size was probably particle shape. The nearer the spheroid the particle approached, the less the contact between the particles and the lower the eddy-current loss, so that some easy way of determining shape seemed to be of great importance. He suggested that if size were taken into account and coupled up with information on air permeability, flow behaviour and possibly packing density, there should be a mathematical way of determining the shape factor from those data.

Mr. C. E. Richards (Post Office Research Station, London) paid a tribute to the work of the Mond Nickel Company in the production of carbonyl-iron in this country and to the initiative of the Controller of Iron Castings, Mr. Fitzherbert Wright, who was Controller of Iron Powder at the time.

Dr. Pfeil said that the magnetically hard materials were invariably used at low flux densities. Early in the war there was at least one case in which those materials were used at relatively high flux densities. In the "TR 115" radio set, when an iron powder with a high hysteresis loss was used, the core became red hot and caused a great deal of trouble. Carbonyl-iron cores never actually gave trouble on that set.

Mr. Polgreen stated in his paper that nickel-iron powder should be better, with regard to eddy-current loss, than carbonyl-iron powder, because it was intrinsically a higher resistivity material. He had thought that was so for a long time, but he could not produce any evidence to show that a 50–50 nickel-iron, which should have a resistivity of approximately 50, was any better with regard to hysteresis loss than carbonyl-iron of the "E" type, whose resistivity is always regarded as 10, the normal figure for iron.

On the question of dealing with the losses, Mr. Polgreen used the Continental system of expressing them, and Mr. Buckley expressed them by the American system. He thought it would be useful if they could decide which system they were going to adopt in this country. The figures are mutually convertible, but it was much easier to be able to read them off one against the other. His own preference was for the American system, but that was probably because he had started using that system before he came into contact with the Continental one.

It might have helped a little if Dr. Pfeil had added some figures for the properties of carbonyl-iron as used in cores. Mr. Buckley quoted in his paper an electrolytic-iron dust with a permeability of 35 and an eddy-current loss of 88. Carbonyl-iron, Grade C, can be pressed up to a permeability of 35 quite easily, but the eddy-current loss, instead of being 88, might perhaps be 2. The hysteresis losses were not very different.

Mr. Randall had mentioned Sendust. It is a variable kind of material, but the only permeability figures the Post Office Research Station had determined agreed more closely with Mr. Polgreen's figure of 70 than with Mr. Randall's figure of 110. His recollection was that the Japanese Sendust obtained before the war gave, as a general rule, a permeability of 60 to 65.

Mr. S. E. Buckley (Standard Telephones and Cables, Ltd., London) agreed with previous speakers who had said that the dust core problem had many unique features. In nickel-iron sheet or strip such elements as sulphur must be kept low, but for dust cores some sulphur must be left in to form a sulphide grain boundary for the subsequent breaking up of the material. The best values of permeability with the lowest hysteresis values were obtained in sheet material when all mechanical strains were kept to a minimum. To get a high permeability core in any make of dust material it was necessary to employ forming pressures by which the particles were strained beyond their elastic limit and had to be restored as far as possible magnetically by heat treatment after pressing. The requirements for the insulation of the core were rather severe. Mr. Randall had already mentioned them. For permeabilities of 100 and over the thickness of the layer of insulation had to be about $\frac{1}{2}\mu$. That had to stand the pressing operation and the heat treatment, which on these cores was usually carried out at about 500 deg. to 600 deg. Cent., whereas it is well-known that the best annealing temperature for strip and sheet was often about 1000 deg. Cent. No insulating materials would withstand heat treatment at any temperature approaching 1000 deg. Cent. when they are present in such small thicknesses. In other applications of powders the strength is obtained in the sintering process, whereas sintering had to be avoided in the heat treatment of the dust cores. Mr. Randall had mentioned the possibility of obtaining an improved heat treatment of dust cores by the use of high-frequency heating, but it seemed that the power required in a case like that would be very high.

Dr. Chaston referred to a paper by Speed and Elmen on electrolytic-iron dust. That material was the one referred to in the earlier part of his paper, where he mentioned the production of cores of permeability 35. Mr. Richards referred to the reduction of eddy-current losses and other losses obtained by the use of carbonyl-iron as compared with the electrolytic-iron dust of Speed and Elmen, and he quite agreed with the values that Mr. Richards had quoted.

Another point that had been raised was the question of the calculation of permeability. There had been a good deal of lively correspondence on that subject in the *Wireless Engineer*. Nearly all the calculations were based on a fairly orderly arrangement of the particles and on a very uniform size of particle, but neither of those conditions obtained in the case of the dust core. Therefore he thought that the full calculation was almost impossible.

Dr. Pfeil raised the point whether the use of higher permeability materials or better methods of insulation were likely to give higher permeabilities. He thought there was scope for both those methods of improving the permeability, but it was possibly a greater scope for the improved methods of insulation. Unless there was a change from the type of alloy used to one which gave better products after it had been strained beyond its elastic limit, the requirement of the insulating layer to withstand the heat treatment in thicknesses less than about $\frac{1}{4}\mu$ would be rather severe.

There was a gap in the availability of metallic materials at present as regards both permeability and losses, inasmuch as one could get thin plates which, in the frequency range of about 100kc to 500kc, had a permeability of about 1000 or several hundred, but the equivalent Q of a coil wound in such a core is only about 1 or less than 1. On the other hand, there were cores with a permeability of about 10 to 20, which would enable one to produce coils of about 100kc with a permeability of 200 or 300. There would appear to be scope for a type of core which had a permeability considerably higher than 10 and perhaps considerably lower than 1000, which would enable one to produce inductances having a much better Q than that now obtained. That again would depend on the development of higher permeability materials, which would give a higher permeability core with existing methods of insulation, or the development of entirely new methods of insulation.

With regard to Mr. Randall's remark about Mr. Polgreen's figures on the variation of the viscosity with the permeability, showing that the higher values were obtained at the higher permeabilities, that was in full agreement with results which he also had obtained independently. He thought the explanation was partly that after the pressing process in the cores which finally have the higher permeability there is less insulation, whereas in the low permeability cores there is considerably more insulation.

The values of the permeability which he had obtained for Sendust were about 67, which agreed quite well with Mr. Richards' figures.

As to Mr. Richards' point with regard to Mr. Polgreen's comparison of the eddy-current loss of nickel-iron alloys with that of carbonyl-iron, if a comparison were made between Sendust, which had a resistivity of about 90–100, and some of the nickel-irons, which had a resistivity of about 40 or 50, then considering cores of the same permeability, made from particles of the same size, the Sendust cores are found to show a lower eddy-current loss.

Mr. Randall referred to Mr. Polgreen's point about magnetic oxides and he mentioned the ferrites. Mr. Polgreen was more concerned in his paper with the low permeability oxides.

The permeability figure of 70 given by Mr. Polgreen for Sendust was obtained from German sources, when the Germans were making Sendust to save nickel, and they did not have much success with it.

The hysteresis loss was dependent on the uniformity of shape as well as on the uniformity of size.

As to the suggestion that the eddy current ought to be better in the nickel-iron than in the carbonyl-iron, the shape factor came into the question. A good shape factor also produced a good eddy current. Some work was being done on producing a nickel-iron alloy of a similar shape to the carbonyl-iron, and the indications were that the eddy-current loss was lower, but the results were not definitely established yet.

Dr. J. C. Chaston (Johnson, Matthey and Co., Ltd., London) said that he was not at all happy about the suggestion, which had been made several times that day, that a low eddy-current loss was necessarily associated with a spherical-shaped particle, because such particles touch at only a few points. He thought that if they made such generalisations, at any rate in that industry, they would very soon come up against a brick wall. Spherical particles might touch at only a few points, but after pressing all those points would have been pressed into one another and the insulation might have been broken through at those points. The only way to find out whether a powder would make a good dust core seemed to be to make a dust core out of it and see. It was not simply that in the carbonyl-iron the particles touched at only a few points and in other irons they touched at many points. It was much more complex than that.

He was interested to hear from Mr. Randall that carbonyl-iron-nickel gives such high values of permeability, and thought that many people would be glad if Mr. Randall could give a few figures of comparison. It had always been his impression that nickel-iron made by the carbonyl-iron process in sheet form was no better than melted nickel-iron alloys and in powder was worse.

The Chairman (Mr. D. A. Oliver), in closing the discussion, said that he believed that the permanent magnets made by powder metallurgy in this country were really better than those made abroad. That underlined the achievements of Mr. Garvin's Company and also underlined the value of the newer features of the technique which has been evolved, utilising not the brittle iron-aluminium, but the cobalt-aluminium powders, which, as is mentioned in the paper, happen to be more resistant to oxidation.

He would like to ask Mr. Garvin whether he had had any experience of the hydrides, as he believed that the metal hydrides had been used to a considerable extent, particu-

larly in America, in the early work on permanent magnets by powder metallurgy.

He thought the ordinary powder metallurgist could co-operate with the magnetic sub-department in methods of testing. The effective permeability could be regarded as an indirect method of measuring average internal stress, and if they were dealing with good powder magnetic properties would enable them to learn a good deal about stress relief, diffusion and sintering generally.

(To be continued)

Cunard White Star Liner "Queen Mary"

IT is announced that the Cunard White Star liner "Queen Mary" is to return to the North Atlantic service of the company and to join the "Queen Elizabeth," which for eight months has carried on the company's Southampton to New York service alone. The newly reconditioned liner was scheduled to sail from Southampton on Thursday, July 31st. We may recall that it is ten years ago since the late Sir Percy Bates, then chairman of the Cunard White Star, Ltd., said at the time the keel of the "Queen Elizabeth" was laid down, that she was the second unit in the long-planned two-ship service across the Atlantic. He then described the "Queen Mary" and the "Queen Elizabeth" as the two smallest and slowest ships for the task, and he envisaged the two great vessels inaugurating that service in 1940. A war in which both ships distinguished themselves for as long as they will sail intervened, and now the "Queen Mary" will make that weekly express service a reality.

THE "QUEEN MARY" AFTER RECONDITIONING

We were recently invited to inspect the almost completed work of reconditioning at Southampton, and on Thursday of last week the "Queen Mary" with some 500 guests on board made a short cruise to the Scilly Isles and on a northward course and carried out successful trials. On returning to Southampton on Friday evening, she anchored half a mile from Cowes, to await the sailing from Southampton of the "Queen Elizabeth," which came into the Solent about 7.30. As the two great liners passed at a distance of about half a mile, three long blasts, followed by three short blasts, were sounded from the sirens of the two liners, after which the "Queen Mary" returned to Southampton to the berth just vacated by the "Queen Elizabeth." The photograph we reproduce was taken specially from the air by our contemporary, *The Daily Telegraph*. The work of transforming the 81,245 gross ton "Queen Mary" from a troop transporter to the ship of beauty she was in 1939 has now been completed. During the years of peace before the war, she carried many thousands of passengers on her voyages to and from New York, and during the war she carried 765,429 Service personnel and steamed 569,943 miles. In the articles published in our issues of May, 1936, we described her public rooms, navigating equipment and propelling and auxiliary machinery; in what follows we record some of the work done in the task of reconversion.

Work of Reconditioning

On September 29, 1946, the "Queen Mary" arrived at Southampton from Halifax, and a few days later there began what must be regarded as the greatest reconversion job ever undertaken on a merchant ship. Fifteen hundred workmen of John Brown and Co., Ltd., of Clydebank, her builders, who had prepared the "Queen Elizabeth" for her maiden commercial voyage on October 16, 1946, began the dismantling of troop fittings.

Many hundreds of standee berths, temporary wooden bulkheads, and great quantities of sanitary equipment of all kinds were speedily put ashore. For many weeks the ship's interior was masked by scaffolding, and the decks resounded to the noise of chipping hammers and the scaling of paint work. While the interior of the ship was approaching a stage at which the work on the reconstruction of public room and cabin accommodation could be begun, work on the upper decks was commenced. The thirty-two lifeboats were removed and were taken to the Northam yard of John I. Thornycroft, Ltd., for overhaul, and whilst the boats were away from the ship an opportunity was taken to dismantle and overhaul all davits and boat winches. Each lifeboat was carefully gone over and its engines overhauled, the food and water tanks cleaned and refilled and the boats themselves scaled and repainted white. About this time the reconversion of the deck rails, on which thousands of troops had carved their names or initials, was undertaken. These were all replaned and polished, with the exception of one length which we are given to understand is preserved in America.

Examination in Dry Dock

A further step was the examination of the underwater parts of the hull in the King George V graving dock at Southampton. The four 35-ton propellers were removed, the tail shafts drawn, and the entire underwater part of the hull scaled and painted with anti-fouling composition. The "Aranbee Fairing," a composition, we may recall, which was used to smooth down the irregularities of the overlapping shell plates, and which had noticeably lessened friction and reduced resistance when steaming at speed, was inspected and renewed where necessary.

New Public Rooms

Before turning to the actual restoration of the public rooms and the provision of new rooms, it is of interest to make brief reference to some of the wartime uses of the ship's accommodation spaces. At the height of the movement of Canadian and United States troops in 1943 the observation lounge foward was a maze of five-tier standee berths. Further aft the main lounge was reserved for a recreation centre for officers, and the first-class smoking room was divided by temporary wooden partitions into a hospital. At the time of our visit these rooms were in a very different condition.

Decorative features had been renewed and the original lighting schemes had again been carried out. It can now be revealed that when the "Queen Mary" first began her trooping service she left behind her, in various parts of the world, enormous quantities of furniture and fittings. In New York 220 boxes and cases were put ashore, while in Australia 2500 doors went into safe storage. The recovery of this material has meant that in many cases cabin and room furnishings were at hand for immediate installation. The task of sorting and renovating such large quantities of furniture and fittings was undertaken in suitably large sheltered buildings and aircraft hangars at Eastleigh, which, it will be remembered, were used in a similar way when reconditioning the "Queen Elizabeth."

Alongside the carrying out of all the reconditioning work was the task of pressing on with all the designs for new public rooms and various new amenities for passengers of all classes and improved accommodation for officers and crew.

A new cinema has been built into the starboard gallery. It is designed to hold 200 persons and is fully air conditioned. Two garden lounges on the promenade deck have been added, which are generally similar in design to those provided in the "Queen Elizabeth." Another innovation is the provision of an air-conditioned cocktail bar at the entrance to the main restaurant. Another new room is the salon, designed as a centre for dancing and furnished with an orchestra platform. It is entered from directly opposite the new recess in the long gallery. For tourist passengers, a self-contained section of the sports deck has been set aside between the first and second funnels, and this is reached by lift from all decks of the tourist accommodation. For the greater convenience of passengers a radio reception office has been built in the space which was formerly taken up by a writing room on the port side entrance to the main lounge. The shopping centre has been improved and fluorescent strip lighting introduced. On the starboard side of the ship the writing room corresponding to the new radio reception office has been retained, but an illuminated "perspex" screen has been introduced which makes this room absolutely independent from the approach to the main lounge.

Propelling and Auxiliary Machinery

As we walked through the machinery spaces we noted little change in the design and layout of the boilers and turbines, which have given such excellent service. Circulating pipes have been fitted to the Yarrow boilers, similar to those described and illustrated for the "Queen Elizabeth" on page 388 in our issue of November 1, 1946. All the twenty-four main water-tube boilers have been inspected and tubes and drums examined. The main turbine casings were lifted and the blading inspected, while all steam pipes were examined. We noted that a small condenser has been added to deal with turbine gland steam. The propeller shafts and bearings were inspected, and the electric wiring surveyed, and in all some 12,000 lighting fittings were replaced. All auxiliary machinery such as the pumps, main and auxiliary generating plant, refrigerating compressors, &c., was overhauled, while in the galleys all electrical equipment was carefully examined and worn parts replaced. The whole of the machinery has been restored to first-class condition.

Report of the Joint Advisory Committee on Conditions in Ironfoundries

In August, 1945, various Employers' organisations and Trade Unions connected with the ironfounding industry were approached by Sir Wilfrid Garrett, then Chief Inspector of Factories, with a view to the formation of a Joint Advisory Committee to consider methods of improving general working conditions in ironfoundries. His suggestion was welcomed and this Committee, consisting of seven representatives of each side of the industry, a Technical Adviser and Inspectors of Factories, was constituted.

On considering the terms of reference and reviewing existing conditions in ironfoundries the Committee felt that the main objectives it should have in mind were :—

(1) Provision of better amenities and more comfortable and healthy working conditions.

(2) Improvement of the appearance of ironfoundries through better cleanliness and orderliness and more light and colour ; and

(3) Improvement of the atmospheric conditions by prevention or removal of dust, smoke and fumes.

The recommendations, embodied in a report which has just been issued, are made with these ends in view.

Included in the report is a section on "New Foundries," summarising the matters which the Committee considered should receive attention when a new foundry is being planned so as to facilitate eventual compliance with its recommendations and with certain statutory requirements.

In existing foundries undesirable features, such as unsuitable buildings or lack of space, often seriously hinder or prevent the attainment of really satisfactory working conditions. Careful attention should be given to these matters when the lay-out of a new foundry is being planned and, for convenience, a summary is given at the end of the report of some of the main points which should receive consideration at the planning stage to enable a good standard of working conditions to be secured.

These recommendations are as follows :—

Moulding, core-making and dressing should be done inside suitable buildings having (*a*) a good weatherproof roof with suitable ventilating arrangements ; (*b*) walls on all sides, and (*c*) ample provision for natural lighting.

Attention should be given to the heat-insulating properties of walls to prevent excessive heat losses in cold weather.

All practicable arrangements should be made to avoid draughts. In particular, openings in outside walls used for the passage of goods or persons should be provided with doors. Internal openings should be similarly provided wherever it is practicable to do so.

All floors should be constructed of concrete, brick, tarmacadam, wood, iron, steel, or other suitable material, except in any part of a foundry where a sand floor is unavoidable owing to the nature of the work.

Every room should be high enough to enable all work to be lifted, handled, or turned over in safety.

Where complete dust and fume control cannot be effected by means of local exhaust ventilation or by other equally effective means, separate rooms should be provided for dressing and for knock-out operations.

A ladle drying station should be provided, and specific areas should be set apart for knock-out and dressing operations to facilitate dust and/or fume control and, where practicable, for core-making. In addition, space should be reserved for storage purposes.

Separate rooms, as necessary, should be provided for the various amenities. The equipment should be of a good standard.

Good unobstructed gangways and pouring aisles should be provided of the following widths :

Gangways.—(i) If not used for carrying molten metal—at least 3ft wide ; (ii) if used for carrying molten metal :

(*a*) Where truck ladles are used exclusively—at least 24in wider than the overall width of the ladle.

(*b*) Where hand shanks are carried by not more than two men—at least 3ft wide.

(*c*) Where hand shanks are carried by more than two men—at least 4ft wide.

(*d*) Where used for simultaneous travel in both directions by men carrying hand shanks—at least 6ft wide.

Pouring Aisles.—(iii) Aisles where molten metal is carried in hand or bull ladles and poured into moulds on moulding floors by not more than two men per ladle—at least 18in wide except where moulds alongside the aisle are more than 20in high above the aisle level, in which case the aisle should not be less than 24in wide. All measurements should be taken between the extreme ends of the box handles or other projections.

(iv) Where molten metal is carried in hand or bull ladles and poured by more than two men per ladle—at least 30in wide.

(v) Where crane, trolley, or truck ladles are used—sufficiently wide to do the work safely.

Where overhead cranes controlled from the floor are used, a clear gangway should be provided for the operator when the crane is handling hot metal.

Arrangements should be made to avoid any work other than furnace work or casting being performed within a distance from the end of the furnace spout of 12ft or three times the diameter of the ladle, whichever is the greater.

The following points should receive attention during the design of cupola charging platforms :—

(i) Platforms should be big enough for the safe handling of raw materials.

(ii) All parts of such platforms, except any part where it would be impracticable to do so, should be covered by a roof at a suitable height above the platform. Ventilation should be adequate to prevent gas from accumulating.

(iii) Platforms should be provided with a suitable level floor and be suitably protected on all sides to prevent falls of men or materials.

(iv) A proper staircase or ramp with handrails should be provided to give access to cupola platforms.

Dust-collecting devices should preferably be installed outside occupied rooms. If they are necessarily installed inside, sites should be chosen which will facilitate the provision of pipes to conduct filtered air to the outside of the building. The use of sludging or other wet methods for removing dust from collectors is desirable.

Mould or core stoves should be so designed and constructed as to prevent, so far as practicable, offensive or injurious fumes from escaping into a workroom when the stove is actually being used for drying purposes. Appropriate steps should also be taken to prevent fumes from entering workrooms at other times.

Particular attention should be given to the general ventilation of foundries where irritating or offensive fumes are given off from bonding materials and also in the vicinity of all knock-outs and dressing processes.

Adequate lighting and heating systems should be installed.

The adoption of colour schemes in ironfoundries would be beneficial and should be considered in all foundries. Consideration should be given to the installation of vacuum cleaning plant.

North of Scotland Hydro-Electric Board—Cowal Scheme

The North of Scotland Hydro-Electric Board has placed the main contracts of the Cowal constructional scheme. This project is designed to supply the electricity demands of consumers in the Cowal district of Argyllshire and the islands of Bute and Cumbrae. The power station, situated on the shores of Loch Striven, will have a capacity of 6000kW, producing annually 14 million units.

For the major part of the civil engineering

work covering the construction of the Glen Tarsan and Glen Lean dams, the main tunnel, aqueducts and road diversion, a contract has been let to Crowley Russell and Co., Ltd., of Glasgow. The Harland Engineering Company, Ltd., Alloa, is to supply and erect the water turbines and electric generators of the Loch Striven generating station.

Plant at Loch Striven will consist of two 3000-kW alternators, directly coupled to Harland "Morgan-Smith" Francis water turbines of 4250 h.p. The normal speed of the turbines will be 600 r.p.m. They will operate at a gross head of 400ft.

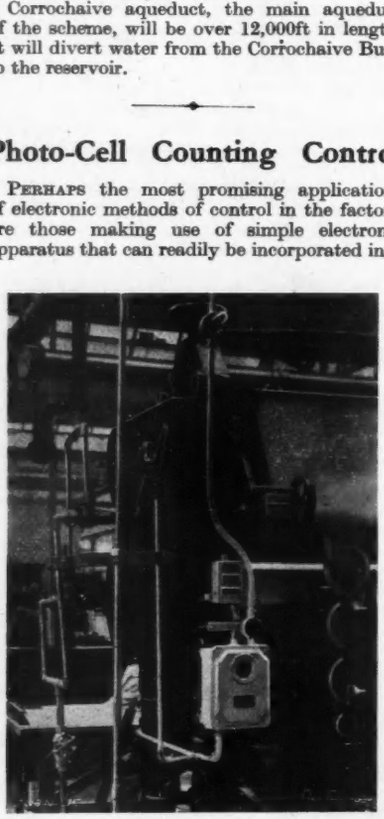
Glen Tarsan dam will have an overall length of 1046ft. One section, 938ft long, will be of concrete buttress type and the remaining 108ft will consist of a concrete cut-off core wall. The buttress section incorporates a 70ft long spill-weir. On top of the dam will be a footway continuing over the spill-weir as a bridge. There will be two gatehouses, one at the eastern end of the spill-weir to control the reservoir-emptying gate and the other at the tunnel intake near the western end of the dam to operate the tunnel gate and screens.

The Glen Tarsan tunnel, which will be over 4000ft long, with an equivalent diameter of 6ft 7in, will be driven from one face. At the lower end of the tunnel there will be a surge shaft 120ft deep and 15ft in diameter. Material excavated during the driving of the tunnel will be used for the construction of the smaller Col dam at the head of Glen Lean. This will be of "rock-fill" construction, 22ft in height and about 580ft in length. It will have a concrete core-wall keyed into the rock.

Corrochaive aqueduct, the main aqueduct of the scheme, will be over 12,000ft in length. It will divert water from the Corrochaive Burn to the reservoir.

Photo-Cell Counting Control

PERHAPS the most promising applications of electronic methods of control in the factory are those making use of simple electronic apparatus that can readily be incorporated into existing machinery with the minimum of modification. A successful example which has caused some interest in the hosiery industry is the photo-cell cell installation carried out by the General Electric Company, Ltd., Magnet House, Kingsway, W.C.2, on fabric calenders in the Leicester factory of Wolsey, Ltd.



FABRIC CALENDER WITH PHOTO-CELL COUNTING CONTROL

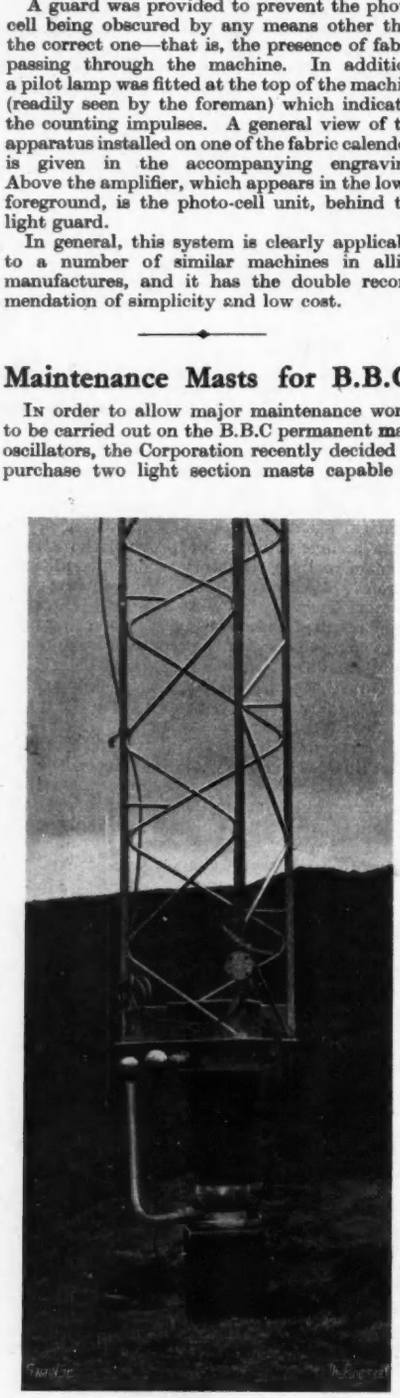
The requirement was to ensure accurate measurement of the amount of fabric passing over steam-heated rollers in a calender machine. With the original counter, employing a friction drive, it was not impossible for the figures to be falsified by pressing on the friction drive so that yardage was recorded even though no fabric was passing over the roller. The new installation retained the counter system, but introduced a small lamp projector, photo-cell extension unit, and amplifier, all standard G.E.C. items. A beam of light was projected on to the cloth, but was prevented by this fabric from illuminating the photo-cell. Under these conditions the yardage count proceeded normally. But when no fabric passed over the rollers, the light fell directly on the photo-cell and the relay in the amplifier unit operated to cut out the counter trip-switch, so that no recording took place.

A guard was provided to prevent the photo-cell being obscured by any means other than the correct one—that is, the presence of fabric passing through the machine. In addition, a pilot lamp was fitted at the top of the machine (readily seen by the foreman) which indicated the counting impulses. A general view of the apparatus installed on one of the fabric calenders is given in the accompanying engraving. Above the amplifier, which appears in the lower foreground, is the photo-cell unit, behind the light guard.

In general, this system is clearly applicable to a number of similar machines in allied manufactures, and it has the double recommendation of simplicity and low cost.

Maintenance Masts for B.B.C.

IN order to allow major maintenance works to be carried out on the B.B.C permanent mast oscillators, the Corporation recently decided to purchase two light section masts capable of being dismantled, transported and quickly erected some 1000ft distant from the permanent masts. These temporary mast oscillators radiate the signals whilst the repairs and maintenance work is in progress on the permanent structures. The specification of requirements for temporary masts issued by M. T. Tudsbery, C.B.E., M. Inst. C.E., the civil engineer, B.B.C., called for masts 300ft in height, triangular in section, with parallel sides, insulated for a peak working voltage of 20kV r.m.s. The mast had to be designed to withstand a wind load of 27 lb per square foot at ground level, rising to 30 lb per square foot at 300ft level. This wind load was to be assumed to act on one and a half times the area of one exposed face. As maintenance work would only be done in the summertime, no ice loading was called for.



BASE OF MAST

As a result of competitive tendering the order for the design, supply and erection was placed with J. L. Eve Construction Company, Ltd. The engraving shows the type of mast supplied. The legs and bracings are of round mild steel rod with connections arc welded. The mast is made up of eighteen sections, each 16ft 8in long, which are bolted together by flange plates. All the steelwork was hot dip galvanised. The base insulator is a Lapp conical insulator with rocker, and the stays are insulated by Doulton egg insulators. Ten such insulators in series are used at the mast connection and single ones every 70ft. The total weight of each mast, including all stays, insulators, foundation blocks, lighting cable and all sundry fittings, is 4½ tons. Each is transported to site loaded on one lorry with trailer. The order was placed in June, 1946, and the masts were designed and manufactured within nine months. Erection, including the installation of the foundations for mast and stays in solid rock, was completed by one gang of five men in two weeks per mast. Special fittings have been designed to facilitate erection.

West Cumberland Atomic Energy Plant

SPEAKING in the House of Commons last week Mr. John Wilmot, the Minister of Supply, gave some further particulars regarding the proposed atomic energy plant at Sellafield, Cumberland. He said that the first stage of the process would be carried out at the Ministry of Supply factory at Springfields, near Preston, and would consist of the production of pure uranium from pitch-blende concentrates. The Sellafield plant will be a production unit for fissile material for use in atomic energy development generally. At the Harwell research station, good progress is being made and the first experimental pile is expected to be in operation later this year. In time it is proposed to build up at Harwell a university of nuclear physics second to none in the world. Work on the pile to carry the process to the next stage will be carried on at the Sellafield factory. At one stage, Mr. Wilmot went on to say, it was hoped to utilise the former explosives factory at Drigg, in West Cumberland, and at that time Courtaulds, Ltd., were considering the laying down of a new rayon factory at Sellafield, north of Drigg. As it seemed likely there would not be sufficient constructional or operative labour for both schemes, the rayon project was abandoned by Courtaulds, and the Sellafield site was considered as an alternative to the Drigg site. Actually, it is more suitable technically and its use is consistent with the planning proposals for the area. Building and engineering works are to be begun immediately and a substantial number of men will be employed for some considerable time.

BASIC ROAD STATISTICS, 1947.—The British Road Federation has just published a new edition of "Basic Road Statistics," giving useful and authoritative statistics and information relating to roads and their use. The booklet is issued in an attempt to bring some order into the confusion which arises from the use of contradictory road statistics and with the object of providing a standard reference on all essential road matters. Although it has been brought up to date as far as possible, much official information which was made public before the war is not now available, and the Federation feels strongly that all possible information appertaining to road transport and road construction should be published in the national interest.

Some Chemical Hazards in the Electrical Industry*

By C. P. FAGAN, B.Sc., A.R.I.C.

WHILE at first sight it might not appear that electrical industry presents any real type of chemical hazard, it must be remembered that the industry exhibits a great diversity, and many electrical firms carry out a number of processes which are essentially chemical in nature.

In a certain electrical firm, where a number of specialised chemical processes are used, hazards arise in connection with the cutting and etching of quartz, electro-plating involving the use of cyanide solutions, paints and varnishes (including the use of solvents for degreasing), &c. The chemist may be called upon to assess such hazards and to advise managements as to the safeguards that should be introduced.

During the war years the number of hazards in industrial processes has risen, partly due to two causes—overcrowding of existing plant and lack of skilled labour.

Hazards in the Cutting and Finishing of Quartz.—A considerable amount of quartz is used annually in order to provide piezo-electric crystals for various purposes. In general, the operations cover grading and cutting of the raw quartz, selection of suitable crystals by means of hydrofluoric acid etching, and final polishing and lapping of crystals. The cutting of quartz is carried out by means of a disc of copper or bakelite which has the edge studded with diamond dust. The operation is not quite as hazardous as it might appear, for the cutting is carried out under wet conditions. The cutting fluid is usually of the oil-water-soap class, and most of the quartz dust produced is washed away into the oil reservoir, from which it can afterwards be recovered as a very fine white powder. A considerable amount of dust gathers in quartz-cutting rooms, even where there is good exhaust ventilation. Examination of this dust shows it to be composed mainly of dried cutting fluid.

Hydrofluoric Acid.—Hydrofluoric acid is used to a considerable extent in quartz crystal manufacture as an etching agent. Most accidents occurring during the use of this acid are due to burns, but the vapour danger cannot be disregarded. It has been known for some time that burns from hydrofluoric acid differ to a considerable extent from other acid burns, inasmuch as the acid causes a horny layer of skin to be formed, under which the acid is still active. Etching of quartz is carried out in large flat gutta-percha trays, and when the acid is fairly concentrated there is danger from fumes. To detect this, a zirconium lake of sodium alizarin sulphonate may be dried on sintered glass tubes or absorbent papers, which are placed in various parts of the room. There is a definite colour change when the concentration of hydrofluoric acid reaches a dangerous figure.

Hazards in Connection with Electro-Plating.—An obvious hazard with plating solutions is that due to cyanide. With silver-plating baths there is some vapour hazard from hydrocyanic acid, when excessive current densities are used. Cyanide copper-plating baths, when used hot, often cause bleeding of the nose, due to fumes. For this reason it is advisable to fix exhaust cowls over this type of bath. Hazards from nickel baths are mainly due to splashing, which, on unprotected skin, often gives rise to an affection known as "nickel itch." Hazards from chromium plating are mainly due to the fine spray of chromic acid solution given off. The effect of this spray on the eyes is very severe, and it has been known to destroy the septum of the nose. Chromic acid is used to a considerable extent in the passivation of zinc.

The danger of accidental poisoning due to swallowing cyanide solutions may be minimised by providing "cyanide antidote" ready for use in a prominent part of the shop. The antidote usually consists of solutions of iron sulphate and sodium carbonate which are mixed immediately before use.

One source of hazard is the consumption of food in shops or departments where poisons are used or stored. While the Factories Act, 1937, prohibits the taking of meals in certain places where chemical processes are used, the ruling only applies to the main mid-day break. During the morning and afternoon "tea break" the consumption of food is not prohibited, and it is left more or less to the employee's discretion. While this rule has obviously been adopted to save time, there can be little doubt that it establishes a dangerous precedent.

A prussic acid vapour concentration of more than 1 part per 100,000 parts of air is rarely found, which means that the vapour hazard in well-ventilated plating shops is very small.

Hazards in Connection with Paints and Varnishes.—A considerable range of paints and varnishes is used in the light electrical industries, mostly as coil dopes, for insulation and other purposes. Many of them to-day are new types of synthetic resin varnishes. Hazards are nearly always due to the solvent or solvents. There may be a fire or a health hazard or both. Acetone is an example of a solvent from which there is a large fire risk, but very small hazards to health. By far the most dangerous solvent from the health point of view, benzene, is also very inflammable.

Methylene choride is one of the least hazardous of the chlorinated hydrocarbons, and there are a number of other solvents which have a fairly "clean sheet" where health hazard is concerned, principal among them being ethyl and propyl alcohol, tetralin (tetrahydronaphthalene), cyclohexanone, acetone, methyl methacrylate monomer, amyl acetate. Solvents which are troublesome from the point of view of health hazards are benzene, toluene, carbon tetrachloride, methyl salicylate.

With regard to fire risks from solvents, an interesting case may be mentioned where a number of girls in a large winding shop were doping coils with an insulating varnish. While each girl possessed about half a pint of the varnish, the amount was large in total, and owing to the inflammability of the solvent the use of the varnish was covered by the Cellulose Regulations. In order to comply with the law, considerable structural alterations would have had to be made. To avoid this a varnish with propyl alcohol as a main solvent was substituted, and this was exempt from the Cellulose Regulations.

Special Risks in Tropical Finishing.—During the war years the tropical finishing of parts has become general in electrical industry. Among the substances used for this purpose are pentachlorophenol, hexachlorobenzene, chlorinated naphthalene waxes, methyl silicon chloride, &c. Both pentachlorophenol and hexachlorobenzene have irritant effects on the throat and nose, more especially when used in the solid form. The chlorinated naphthalene waxes, when heated above their melting points, give rise to fumes with a dangerous action on the liver. For this reason, chlorinated naphthalene waxes should only be used when there is a good draught. Methyl silicon chloride (CH_3SiCl_3) requires special mention. This substance is used to give water-repellent properties to ceramics, &c. The substance itself is a fuming liquid of low boiling-point, which is applied to the ceramic surface by brushing or dipping. After treatment with the chemical, the parts are washed in water, when hydrolysis of the methyl silicon chloride takes place, with the production of a long-chain polymer. This polymer, which coats the article, has water-repellent properties. It is, in fact, a silicone. The hazards from methyl silicon chloride are due to inhalation of the vapour, which may cause the lungs and air passages to be coated with water-repellent films and lead to asphyxiation. Here, as in the former instance, adequate protection by draught is necessary. It may also be noted that methyl silicon chloride may inflict burns on the skin. These are not usually serious and resemble acid burns to a great extent.

There are a number of proprietary impregnants for wood which contain a considerable proportion of arsenite or arsenate. The hazard here is obvious.

Special Risks in the Valve Industry.—An unusual substance used in valve manufacture is barium azide (BaN_6), which is useful because, when heated *in vacuo*, it decomposes quickly, nitrogen being liberated and barium metal being obtained. The substance is usually applied to valve parts in the form of a saturated solution, the operations being carried out in a well-enclosed fume cupboard, as the substance is rather more poisonous than other compounds of barium. The hazards from this substance may be summarised thus:—The compound is spontaneously explosive under certain conditions and on no account must large crystals be allowed to form in stored bottles of a saturated solution; lead drains or ducts must not be installed where barium azide is used, because of the danger of forming explosive lead azide. Ceramic drains are recommended. Uralite is a good material to use for draught systems; acids must be kept far away from azide solutions because of the danger of forming explosive hydrazoic acid. When used intelligently, however, there is little hazard from barium azide, which is one of the least explosive azides of the heavier metals.

Experience during the last few years indicates that certain sections of the Factories Act, 1937, are in need of expansion and revision, more especially the parts dealing with paints and solvents.

* The Royal Institute of Chemistry.—Abstract.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

LOW HEAT CEMENT

No. 1370 : 1947. This specification covers a type of Portland cement intended for use in structures, such as dams, where large masses of concrete have to be placed, and aims at overcoming some of the difficulties met with if ordinary Portland cement is used for this purpose. For many years engineers have recognised that the major cause of shrinkage cracking in large masses of concrete is the high temperature generated within the mass during the hardening period and the consequent contraction on cooling. It has been found that in dams of moderate size, *e.g.*, 50ft to 150ft high, laid at normal rates, the temperature of the concrete may rise 50 deg. to 80 deg. Fah., after being laid, the maximum temperature occurring after one or two months or even later in the case of very large dams. Similar temperature rises occur when bridge abutments, massive retaining walls, piers and slabs, &c., are being built. This problem has been studied by sub-committees set up by the international and British committees on large dams, and the experience gained from investigations in this country and abroad has led to the preparation of this specification, which covers a Portland cement with a reduced heat of hydration as a solution to the problem.

The reduction in the heat of hydration, as compared with ordinary Portland cement (B.S. 12 : 1940) has been achieved by fine grinding the cement, which also has the effect of reducing the tendency of a concrete mix to segregate and the consequent separation of water at its surface and by a reduction in the maximum permissible lime content. These changes do not affect the ultimate strength of the cement, though the rate of strength development is appreciably lower than in the case of ordinary Portland cement. The specification defines the methods to be used in selecting samples for testing and the appropriate tests for fineness, chemical composition, strength setting time, roundness and heat of hydration. The test for fineness is to be carried out by the determination of the surface area per unit weight of the sample by means of a permeability cell connected to a manometer and flow meter, as it has been found that the conventional sieve tests give no indication of the size of the finer particles. The necessary apparatus and method of operation are described in detail. The strength of the cement is to be measured by compressive strength tests on mortar cubes compacted by means of a vibrating machine. The tensile strength test on mortar briquettes used for ordinary Portland cement is eliminated from this specification. The heat of hydration of the cement is determined by dissolving the dry cement in a nitric-hydrofluoric acid solution in a calorimeter. Similar solutions are made of hydrated samples which have been cured for seven and twenty-eight days respectively, and the total heat evolved during these periods calculated from the differences between the several results.

Price 3s. 6d. net post free.

Industrial and Labour Notes

The Organisation of Nationalised Industry

In the past few months many questions have been asked, both inside and outside Parliament, regarding the organisation and running of nationalised industries. It is of interest, therefore, to note that the matter was raised on the motion for the adjournment of the House of Commons on Tuesday of last week.

Mr. Geoffrey Cooper, who opened the debate, expressed the view that the question of the organisation of our nationalised industries was one which would affect very vitally the productivity of this country. He believed that, so far, nationalisation did not really mean anything vital to the people of the country, and said that it was no use just passing a measure to nationalise industry unless it could be ensured that the method of running that industry afterwards was going to be exemplary in every detail. Mr. Cooper went on to suggest that the chief reaction among workers in nationalised industries was a sense of dissatisfaction and discontent, as the individual worker was not being given an opportunity to express himself as an intelligent and vital member of a communal enterprise. Until the new boards appreciated that they had to take specific responsibility for introducing new methods into nationalised industry, he thought nationalisation would fail.

The Paymaster-General, Mr. H. A. Marquand, replying in the debate, said that he could not agree that there had been nationalisation in name only, with no significant change to the workers in industry. He did agree, however, that the enthusiasm of the workpeople in those industries needed to be canalised if it was to have its full value. The Government, Mr. Marquand stated, accepted in full the principle of joint consultation in industry, and wanted to foster joint consultation in public, as well as in privately owned industries. Referring specifically to coal mining, Mr. Marquand said that, though he was anxious to see the best possible relations established in the industry he thought it would be a mistake to try to adopt too suddenly, too surprisingly, all kinds of experiments which might have been tried out in other industries. The men must be trusted to go slowly in this difficult work, and here, as elsewhere, good managements could make joint consultation work. His conclusion was that where there was a really good management one could make joint consultation work, and in so far as coal mining, civil aviation and other nationalised industries were concerned, the task would be, in the first place, to secure good managements. Mr. Marquand, however, did not rule out the desirability of those nationalised industries studying the practice of other industries.

The National Joint Advisory Council

The National Joint Advisory Council, made up of representatives of the British Employers' Confederation and the Trades Union Congress, met in London on Wednesday of last week, under the chairmanship of the Minister of Labour, and discussed several matters which are at present causing industry a great deal of concern.

The question of wage incentives was one of the items considered, but the Council felt that the introduction or development of incentive payments was one which could be determined only by the two sides of each industry. It recommended, however, that, as a means of increasing production, joint consideration should be given in all industries and services to the desirability and practicability of introducing or extending systems of payment which provided the maximum incentive to increase output.

Hours of work in relation to output per man-year was another matter discussed by the Council. The feeling was that this was a subject which could not be dealt with adequately at the present time, as the aftermath of the fuel crisis made it difficult to form any reliable conclusions. On the other hand, the Council agreed upon ways in which the Ministry of Labour might be of assistance to industry in the establishment of joint consultative machinery for the regular exchange of views between employers and workers on production questions.

In discussing the distribution of manpower, the T.U.C. representatives on the Council asked that the information contained in Part III of "The Economic Survey for 1947" should, as far as possible, be brought up to date so that an authoritative statement could be made to the Council regarding the development of the economic situation in the coming months. Both sides of the Council agreed on the desirability of such information being made available at the earliest possible date.

It may be recalled that Part III of "The Economic Survey" included information relating to production and export targets for 1947, commenting also on transport and capital equipment requirements. To reach the objectives mentioned, it was stated that the Government's plan envisaged a total civil employment of 18,400,000 by the end of this year, and "the problem of getting this manpower into the right places" was one of the points to which attention was directed in "The Economic Survey."

Staggering of Working Hours

When the Minister of Labour made a statement in Parliament last week regarding the Government's plans for spreading the electricity load during next winter, he said that the recent agreement on the staggering of working hours in the engineering industry afforded a useful lead to industries generally. The Trades Union Congress has now sent to all its affiliated unions a copy of this agreement, suggesting that it should be used as a guide in negotiating staggering arrangements in the industries which they represent. The General Council of the T.U.C. has, at the same time, drawn special attention to the need for ensuring that adequate transport arrangements are made to meet revised hours of working.

The British Employers' Confederation has also sent copies of the engineering industry's agreement to its affiliated organisations.

The Trades Union Congress

The seventy-ninth annual Trades Union Congress opens at Southport on September 1st, and, as was to be expected, questions of production, manpower and other aspects of the country's economic situation occupy a prominent place in the lengthy agenda.

The National Union of Railwaymen, for instance, is submitting a motion urging all the T.U.C.'s affiliated organisations to consider the best ways and means of securing the fullest productive capacity of their members, and to examine towards this end the machinery operating in their respective industries. The motion requests the T.U.C. General Council to review and enlarge the educational opportunities open to trade unionists so as to give the workers the necessary background and qualifications for the "greater responsibilities which must of necessity fall upon them."

The setting up by the Government of an Economic Planning Board is welcomed by the Amalgamated Union of Foundry Workers which expresses, in a resolution, the hope that there will be "early practical results by way of an overall plan for industry." This resolution also calls for trade union representation on planning committees at every level of production. Furthermore, it demands that joint production committees should be made compulsory in industry, a matter which is supported by the Association of Engineering and Shipbuilding Draughtsmen, the Amalgamated Engineering Union and the National Union of Vehicle Builders.

The Electrical Trades Union urges the Congress to call upon the Government to prepare and issue immediately an economic plan for Britain's essential industries. The resolution embodying this suggestion says that such a plan should indicate clearly priorities and production targets to be achieved in the next two years. Another matter to which the Electrical Trades Union is to draw attention at the Congress is the major *rôle* which the shipbuilding and ship repairing industry must play in the restoration of the country's prosperity. A resolution declares that as a matter of urgency there should be the fullest investigation by the Government into production methods in the shipbuilding industry, with a view to the co-ordination and standardisation of operations. The resolution adds that, in order to guarantee full employment, there should be provision for alternative work for the shipyards "as and when the immediate replacement needs are met."

Trade Unions in Canada

The Canadian Department of Labour has recently published its thirty-fifth annual report on labour organisation in Canada containing statistics and information about trade unionism in the Dominion in 1945. This report shows that, at the end of 1945, there were 4329 local unions or branches of unions in Canada, with a total membership of 711,117. The majority of these local unions or branches were constituents of about 100 "international" unions which had their headquarters in the U.S.A. with branches there and in Canada. The remainder belonged to some sixty Canadian national, federal or local unions.

A table included in the report analyses the general trend of trade unionism over a number of years, by showing the numbers of local unions or branches and the total number of trade union members at the end of each year from 1931 to 1945. Union membership increased most rapidly during the war, and between 1940 and 1941 there was an overall rise of 27·5 per cent. Thereafter, membership continued to grow, but at a decreasing rate, the peak being reached in 1944 with a total of 724,188 members, after which there was a recession resulting in a drop of 1·8 per cent to the 1945 figure of 711,117.

The metals industries, which embrace one-fifth of the total union membership, suffered the most serious decline (a decrease of 23·5 per cent between 1944 and 1945). Smaller union groups representing mining and quarrying and light, heat and power lost roughly 3½ per cent of their membership in the same period. At the same time, substantial increases were recorded in the membership of unions representing transport, construction, clothing, printing and publishing, reflecting, to some extent, the beginning of the changeover from war to peacetime production.

The Future of the Steel Industry

The annual general meeting of Richard Thomas and Baldwins, Ltd., was held on Wednesday, July 30th, and in a statement presented with the annual report, the chairman, Mr. E. H. Lever, commented briefly on the future of the iron and steel industry. Uncertainty regarding the Government's proposals for that industry, Mr. Lever's statement said, was naturally a considerable handicap, 'but while responsibility remained in present hands, the clear duty of the industry was to press ahead with its plans and not to do anything to retard national recovery.

In any matter which came within the category of problems involving overall national policy, the statement continued, it was proper, and the iron and steel industry had always accepted, that the community, through the Government of the day, should not only have a voice, but should be the final arbiter, provided that decisions were taken after full consultation not only with the industry but with all the parties concerned. The company, however, the statement added, still held firmly to the view that that objective could be achieved without resort to the extreme methods of state ownership and management.

French Engineering News

(From our French Correspondent)

PARIS, July 25th

The abundance and low costs of hydraulic power produced and consumed in the Alps have induced a number of businesses, mainly factories for metallurgical products, to be set up in Savoy. These factories have provided an important decentralisation and work for a semi-agricultural, semi-industrial population, who are dependent on abundant power at low costs. The Minister of Production has therefore been asked to consider the repercussions which would follow on a national, uniform price for electricity, and to take into account the situation of factories and their proximity to sources of production.

* * *

The Société Nationale d'Etude et de Construction de Moteurs d'Aviation has just published its report in the *Journal Officiel* (French Hansard). On January 1, 1946, a total of 5472 engines were ordered. Of this number, 2937 were delivered in the course of the year, the equivalent of 277 engines were delivered in spare parts, and 1600 were repaired. Some reconversion was carried out in the production of motor cycles, and in spite of difficulties 900 "velomotors" (motorised cycles) and 400 motor cycles were produced. Main reconversion efforts, however, were concentrated on agricultural tractors, and by autumn, 1947, 100 a month will be turned out. At Gennevilliers, the foundries were able to re-establish their production capacity after repairs necessitated by war damage. It is pointed out, however, that the future of the Société depends on the aeronautic programme which will be set up, and as yet there is no indication what this is likely to comprise.

* * *

Rolling stock orders by the S.N.C.F. include 11,200 goods trucks and 450 passenger carriages, of which 350 are intended for main lines. In the construction of the latter, engineers are emphasising three points: the maximum of safety, a reduction in deadweight and the greatest possible comfort. All-metal, tubular welded frames will produce maximum resistance in the event of accident. The use of steel in the frames, with light alloys for most of the finishing, will reduce the weight, enabling speed to be increased, or the number of coaches per train increased. To improve comfort, the new bogies will be fitted with a new design of suspension. The carriages will be heat and noise-insulated, for coolness in summer and warmth in winter. Following the referendum organised among passengers some months ago, the S.N.C.F. is to enlarge windows, which will be of non-splintering glass. On branch lines, steel carriages similar to those now serving certain suburban lines will be used. For the future, the S.N.C.F. is studying proposals for trains composed of only six carriages, mounted on rubber tyres for journeys from Paris to Bordeaux, Paris–Lyons–Marseilles, and Paris to Strasbourg. The new system would, it is claimed, increase speed and produce comfort hitherto unknown on railways.

* * *

The question of setting up a chain of cold stores in Morocco, to ensure that produce will be kept constantly at the required temperature during transport, is being discussed. It is proposed to set up installations at the place of production, regional storehouses and warehouses at ports. At the moment Casablanca is being considered as the main storage port, although others may be used for this purpose in the future. At Casa-port, for example, refrigerated storage for 100 tons of tomatoes will be available in a building 150m by 58m. Produce will arrive by road or rail and be taken up to the first floor in loads of 2 or 3 tons. Here they will be arranged so as to reduce the space between them as far as possible. The necessary refrigeration would operate within ten hours, the whole operation of loading, refrigerating and embarkment taking less than twenty-four hours. All boats used will have ventilated, refrigerated holds.

Notes and Memoranda

Rail and Road

RECRUITMENT OF RAILWAYMEN.—In a recent written reply, the Minister of Transport stated that, since the withdrawal of the Essential Work Order, up to April 30th last, 72,022 people had joined the staffs of the British main line railway companies. This total is made up of 47,731 conciliation staff, 15,529 workshop staff and 8762 supervisory staff.

G.W.R. RAIL BRIDGE FOR ROAD BY-PASS.—At the request of the Devon County Council, the Great Western Railway is to construct a new bridge near Totnes to carry the Totnes By-pass road over its main line. The bridge superstructure will consist of a single reinforced concrete skew span of 62ft with parapet walls of local stone, the substructure being mass concrete with local stone facings. The bridge will carry a 30ft wide roadway, with two 5ft footpaths.

RAILWAY EARNINGS.—The Minister of Transport stated recently, in reply to a parliamentary question, that it was estimated that in 1947 the pooled net revenues of the main line railway companies would fall short of the fixed annual sums payable to them under the Railway Control Agreement by some £37,000,000. The Control Agreement would be terminated at the end of this year, when the railways would pass to the British Transport Commission, but an estimate on a similar basis for 1948 indicated a deficiency of about £28,000,000. The Minister added that neither estimate took account of any additional cost which would be incurred should effect be given to the recent recommendation of the Court of Inquiry into railwaymen's wages and hours of work.

RED-AMBER SIGNAL TO REMAIN.—The Minister of Transport has decided that there is to be no change in the sequence of traffic light signals. This decision has been reached after careful consideration of the reports on the recent experiments carried out at thirty-five crossings in London, Liverpool, Glasgow and Gloucestershire, at which, during the past twelve months, the red-with-amber signal has been omitted. The experiments, which were to have been conducted in 1939, but were postponed on account of the war, have been kept under close observation by Ministry of Transport officials, the highway authorities and the police. In addition, motoring and other road users' organisations reported on them. The numbers and types of accidents which occurred at each crossing for an equal period before and after the change-over showed no marked difference, and there was no conclusive evidence that the omission of the red-with-amber would increase road safety. On the other hand, the experiments indicated that the modified sequence gave rise to delay in vehicles starting up, as drivers no longer received the warning provided by the amber signal. It was also noticed that when drivers got accustomed to the new sequence they tended to run late in the amber phase, knowing that the opposing traffic had not been given the red-with-amber signal. At the same time, some waiting drivers tended to watch for the reflection of the amber signal facing the running traffic and start against the red signal—a practice at least as dangerous as that of starting on the red-with-amber signal.

Air and Water

SWEDISH SHIPS FOR RUSSIA.—According to *The Anglo-Swedish Review*, Sweden is to build fifty ships for Russia at a cost of between 60 and 80 million kronen. Twenty of the ships are intended for seal hunting in Arctic waters, while the rest will be cargo ships. The ships for seal hunting, it is reported, are to be constructed in such a way that they will not be destroyed by ice, but will be forced upwards by its pressure. It is understood that under the Russo-Swedish trade agreement Sweden is to deliver forty-five fishing trawlers and fifty cargo motor schooners to Russia.

AERONAUTICAL RESEARCH IN AUSTRALIA.—According to the Australian *Aviation Bulletin*, aeronautical research at present being carried out in Australia includes investigation into the method of reducing air resistance by the Griffith wing principle. This design permits of thicker and narrower wings, and is an approach to the "flying wing" with space for accommodation for passengers and freight inside the wing itself. Supersonic flight is also being studied, and because of unequalled facilities for testing over large uninhabited areas, Australia, it is suggested, may become a leading centre for this line of research. The Division of Aeronautical Research of the Australian Council for Scientific and Industrial Research is taking a prominent part in investigation work. Amongst other things, the Division developed during the war special aircraft wings and a new type of engine installation was also worked out so as to utilise a large part of the energy wasted in the engine exhaust. Performance tests of another type of engine enabled it to extend appreciably the operational range of the aircraft.

HELICOPTER FOR R.A.A.F.—A Sikorski helicopter, ordered by the R.A.A.F. for experimental purposes, is expected to arrive in Australia during this month. It will be attached initially to the R.A.A.F. Aircraft Performance Unit at Point Cook, Victoria, where tests and investigations will be made to assess the value and scope of this type of aircraft to Australia during peace and war. It is believed that the helicopter will be the answer to the Australian bush-fire problem, as parties of men can be dropped near a spot fire to keep it under control. The helicopter will also be of value in the anti-pest and photographic fields.

Miscellanea

TIN STOCKS.—The Ministry of Supply states that, at June 30th, its stocks of tin metal totalled 5219 tons, and that consumers' stocks amounted to 3824 tons. Consumption of tin metal during June was 2180 tons, and at the end of the month stocks of tin ore stood at 6306 tons.

MODEL ENGINEER EXHIBITION, 1947.—It is announced that the twenty-second Model Engineer Exhibition will be open at the New Royal Horticultural Hall, Westminster, from Wednesday, August 20, until Saturday, August 30, 1947. Among the items of special interest which will be seen at the exhibition are model speed boats and cars controlled from a distance by radio; a model showing a road lay-out with vehicles controlled and driven by electricity; and a grand circular track, in which speeding model cars and boats and flying aircraft will give displays. It is stated that the models which have been entered for the various championship cup competitions this year are as ingenious as they are varied.

"THE CONSULTING ENGINEER YEAR BOOK."—The first edition of "The Consulting Engineer Year Book" has recently been compiled under the direction of an editorial committee, of which Mr. J. B. Pinkerton, M. Cons. E., is chairman. The book provides an up-to-date reference to the careers of many consulting engineers practising in this country and overseas, and also reviews the work of consultants in civil, mechanical and electrical engineering. Codes of practice, lists of British Standard Specifications and information on the Working Rule Agreement of the Civil Engineering Construction Conciliation Board are other useful features of the book, which is published by Princes Press, Ltd., 147, Victoria Street, London, S.W.1, at 15s.

AMERICAN IRON ORE PRODUCTION.—The opening of the Lake Superior shipping season on April 13th, made possible a production of iron ore in the Lake Superior district in April nearly four times that of March, according to the United States Bureau of Mines. American iron ore production in April totalled 6,574,653 gross tons, compared with 2,846,168 tons in the previous month. Deliveries increased greatly during April, and totalled 7,216,400 gross tons. In March deliveries were 1,425,200 tons. By-product ore production totalled 45,321 gross tons in April, compared with 51,542 tons in March. Deliveries of this material during April to the iron and steel industry amounted to 56,106 tons, a decrease of 15 per cent compared with March.

ANTHRACITE DUST PROBLEMS.—Adequate ventilation and the liberal use of water sprays are the two most effective ways to control coal dust hazards in anthracite mines and to protect workers from the respiratory disease known as anthracosilicosis, according to a wartime survey made by the U.S. Bureau of Mines in thirty-eight collieries in the Pennsylvania anthracite region. The report of the survey says that water reduces the amount of dust in air at least 80 per cent when used in connection with certain mining operations and greatly improves illumination. It also proves effective when spraying underground working sections and newly blasted areas. The most efficient types of water pipe lines, sprays and pumps are discussed in the report. Discussing individual protection against dust, the report points out that respirators are worn in some mines, but that they should be used only as a last resort when dust cannot be controlled adequately at its source and they should be kept in good condition at all times. In one mine, a periodic physical examination also was given and each miner was X-rayed for signs of anthracosilicosis.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Engineering and Marine Exhibition

Thursday, August 28th, to Saturday, September 13th.—London, Olympia.

Institute of Marine Engineers

Tuesday, September 9th.—85, Minories, E.C.3. Presidential Address, Sir Amos L. Ayre. Paper: "Steam Pipework Design in Ships." Lieut. (E) P. T. Hoath. 5.30 p.m.

Institution of Naval Architects

Tuesday, September 23rd, to Friday, September 26th.—Autumn meetings at Portsmouth and Southampton.

Catalogues

WILD-BARFIELD ELECTRIC FURNACES, Ltd., Watford By-pass, Watford, Herts.—Pamphlet dealing with furnaces for workshop use.

PROTOLITE, Ltd., Central House, Upper Woburn Place, W.C.1.—Booklet No. P.14, entitled "Instructions for Brazing and Grinding."

PYROMETER INSTRUMENT COMPANY, 103, Lafayette Street, New York, U.S.A.—Catalogue describing the "Pyro" surface pyrometer.

FRASER AND CHALMERS ENGINEERING WORKS, Erith, Kent.—Catalogue dealing with the Chances and flotation process for cleaning coal.

WILLIAM JESSOP AND SONS, Ltd., Brightside Works, Sheffield, 1.—Brochure on magnet steels and high-performance magnet alloys.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., Elecfurn Works, Watford By-pass, Watford.—Pamphlet dealing with the "Hairpin-Minor" furnaces.

"MONITOR" PATENT SAFETY DEVICES, Ltd., "Monitor" Works, King's Road, Wallsend-on-Tyne.—Leaflet No.114 on the "Monitor" alarms and controls.

RUNBAKEN ELECTRICAL PRODUCTS, 71–73A, Oxford Road, Manchester, 1.—Leaflet describing the new "Midget" grinders and attachments.

BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., Duke's Court, 32, Duke Street, St. James's, S.W.1.—Catalogue on power from process steam.

BRITISH ALUMINIUM COMPANY, Ltd., Salisbury House, London Wall, E.C.2.—Catalogue on wrought aluminium and aluminium alloys sizes and weights.

E. H. JONES (MACHINE TOOLS), Ltd., Edgware Road, The Hyde, N.W.9.—Leaflet dealing with the "Sigma" inspection equipment for mass-produced parts.

WALKER, CROSWELLER AND CO., Ltd., Whaddon Works, Cheltenham, Glos.—Pamphlets describing the Leonard-Thermostatic steam and water mixers.

HARRIS ENGINEERING COMPANY, York Works, Browning Street, S.E.17.—Pamphlet on the modern method of heating industrial and business buildings by gas.

BLAW-KNOX, Ltd., Clifton House, Euston Road, N.W.1.—Specification sheets describing 14S "Rex" concrete mixer and mobile "Junior" weighbatcher.

SPIRAX MANUFACTURING COMPANY, Ltd., Cheltenham, Glos.—Bulletin No. 15, dealing with the draining and air venting of heating, cooking and hospital equipment.

HEAT AND AIR SYSTEMS, Ltd., Coastal Chambers, 172, Buckingham Palace Road, S.W.1.—Brochure on air conditioning, heating and industrial process engineering.

MOTOR GEAR AND ENGINEERING COMPANY, Ltd., Essex and Corona Works, Chadwell Heath, Essex.—Illustrated catalogue on universal joints, gears and machine tools.

BIRMINGHAM ALUMINIUM CASTING (1903) COMPANY, Ltd., Birmid Works, Dartmouth Road, Smethwick.—Illustrated brochure, entitled "A Guide to the Selection of Suitable Casting Alloys in Aluminium, Magnesium and Zinc."

Launches and Trial Trips

KOROMIKO, motor vessel; built by Alexander Stephen and Sons, Ltd., for the Union Steam Ship Company; length 325ft, breadth 50ft, depth 26ft; gross tonnage 3700. Engines, single six-cylinder, two-cycle Stephen-Sulzer diesel, developing 3000 b.h.p. at 150 r.p.m. Launch, July 22nd.

GEIR, steam trawler; built by Cook, Welton and Gemmell, Ltd., for the Icelandic Government; length 175ft, breadth 30ft, depth 16ft; gross tonnage 650. Engines, set of triple-expansion, cylinders 16½in, 28½in, 47in bore, 30in stroke, supplied by Charles D. Holmes and Co., Ltd. Launch, July 21st.

Personal and Business

MR. J. N. KILBY, M.I. Mech. E., has joined the board of the Blaenavon Company, Ltd.

MR. C. F. J. LISLE, B.Sc. (Eng.), Assoc. M. Inst. C.E., has been appointed water engineer and manager to the County Borough of Tynemouth.

MR. L. N. BURT, M.I. Mech. E., M. Cons. E., announces that his address is now 32A, College Road, Harrow, Middlesex (telephone, Harrow 0235).

DR. H. O'NEILL, chief metallurgist to the London, Midland and Scottish Railway Company has been appointed Professor of Metallurgy at the University of Swansea.

THE INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS states that its address is now 68, Victoria Street, Westminster, S.W.1 (telephone, Victoria 8237).

WHESSOE, Ltd., announces that it has been placed on the Lloyd's Register list of recognised manufacturers of Class I welded pressure vessels (fusion welding).

MR. B. CHETWYND TALBOT has been appointed deputy chairman and general manager of the South Durham Steel and Iron Company, Ltd., and the Cargo Fleet Iron Company, Ltd.

MR. J. H. KEELING has been appointed deputy chairman of British European Airways. Lord Kershaw and Sir Francis Brake have been appointed directors of British South American Airways.

HEENAN AND FROUDE, Ltd., has acquired the whole of the shares in W. G. Bagnall, Ltd., Stafford. The board of W. G. Bagnall, Ltd., has been reconstituted as follows:—Mr. A. P. Good (chairman), Mr. J. Fielding, the Hon. A. C. Geddes, Mr. I. A. Marriott, Mr. C. Hill. Mr. W. O. J. Urry has been appointed secretary of the company.

THE MINISTRY OF TRANSPORT states that Mr. G. H. Hargreaves, M. Inst. C.E., has been appointed divisional road engineer, Metropolitan Division, on the retirement of Mr. W. C. Clemens, M. Inst. C.E. Mr. J. F. A. Baker, Assoc. M. Inst. C.E., has been appointed divisional road engineer, Wales and Monmouthshire, in succession to Mr. Hargreaves.

CROMPTON PARKINSON, Ltd., states that from August 5th its London address will be Aston House, Aldwych, W.C.2, (telephone, Chancery 3333; telegrams, Crompark, Estrand, London; cables, Crompark, London). The electric vehicle division is remaining at Electra House, Victoria Embankment, W.C.2, but its telephone number, telegraphic and cable addresses will be as stated above.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., announces that Dr. C. Dannatt, chief electrical engineer, has been appointed a director. The company also states that Mr. A. J. Crawford has succeeded Mr. H. Paterson as manager of the Newcastle-upon-Tyne office, and that Mr. J. B. Hartley has succeeded Mr. C. Petersen as manager of the Manchester office. Both Mr. Paterson and Mr. Petersen will remain available for consultation until the end of the year.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s. d.
B.I.O.S.:		
459	The German Coated Abrasives Industry	1 7
720	Metallurgical Research and Testing Laboratories in the Stuttgart Area	16 4
853	I.G. Leverkusen: Azobenzene...	1 1
905	The German Agricultural Tractor Industry in the United States and French Zones of Occupation	5 2
1008	Rhenania Ossag A.G. Hamburg, Germany: Fuels and Lubricants	16 4
1065	Investigation of German Plastic Plants: Part V, Thermosetting Resins (Part I, C.I.O.S., XXIX-62; Part II, C.I.O.S., XXXIII-23; Part III, B.I.O.S., 445; and Part IV, B.I.O.S., 433) ...	17 11
1066	German Glass Manufacturing Equipment	1 7
1097	German Battery Electric Road Vehicles	5 2
1109	Pressure Gauges: The Activities and Products of the Firm of J. C. Eckardt A.G., Bad Cannstadt, Stuttgart	1 0
1118	Final Report on the Investigation of the Use of Industrial Glassware for Chemical Plants in Germany	0 7
1133	Materials and Machines Used in the Manufacture of Cellulose Acetate Rayon	6 8
1143	The Manufacture of a-Nitronaphthalene, a-Naphthylamine, and a-Naphthol at I.G. Farbenindustrie, Leverkusen	2 8
1173	Corrosion of German Naval Boilers with Particular Reference to De-aeration of Feed Water	18 4
F.I.A.T.:		
383	M.A.N. Dry Dock Cranes at Blohm and Voss Shipyard ...	2 8
894	Electrostatic High-Voltage Generators	1 7
909	The Cerium Metal and Lighter Flint Industry in Germany and Austria	1 7
927	Production of High-Alumina Slags in Blast-Furnaces and Allied Processes for Recovering Alumina	3 2
929	Effluent Treatment Practices in Some of the Chemical Factories in the French, British and American Zones of Occupation in Germany	3 8
960	Polyethylenimine and Its Use in Paper-Making	0 7
961	Paper and Textile Machine Design Relating to the Manufacture of Wadding, Facial Tissue, Sanitary Napkins and Thin Tissues	1 7
962	Details of Manufacture of Tanigans Extra A, C and F	1 1
972	The Manufacture of Chlorobromomethane Fire Extinguishing Agent "C B"	1 1
B.I.O.S.:		
Misc. 3	(1) The German Rubber Footwear Industry; (2) The German Sole and Heel Industry	6 8
Misc. 16 ...	Lacquering Methods for Food Cans	0 7
EVALUATION REPORTS (post free 3d.)—		
B.I.O.S.:		
E/R 25 ...	Holzetia Werke A.G.: Plywood	
E/R 237 ...	Demag: Gear Cutting, Air Compressors, &c.	
E/R 258 ...	Heereswaffenamt: Specifications and Tests of Welding for the Services	
E/R 262 ...	Coke Production and By-Products	
E/R 268 ...	(a) Demag (Benrath), (b) Menck and Hambrock, (c) Weserhutte A.G., (d) Lubecke Maschinenbau Gesellschaft; (e) Nilsson and Korte; (f) Demag A.G. (Duisburg): Contractors' Plants	
E/R 290 ...	Heinrich Lanz A.G.: Agricultural Machinery Manufacturers	
E/R 341 ...	Ernst Carstens: Wood-Working Machinery	
E/R 519 ...	Chemische Fabrik Wesseling: Inorganic Chemicals/Sulphur Extraction	
E/R 560 ...	Interview with Dr. Helmut Thaler: Cacao Research in Germany	
B.I.O.S.:		
394	Technical Report on the Ruhr Coalfield (Vol. 2 in two parts. This report has been published separately by H.M. Stationery Office as a Ministry of Fuel and Power publication and should be ordered by title)	25 8
576	German Lime-Burning Industry	14 4
756	Polymeric Processes at I.G. Ludwigshafen	2 1
765	German Locomotive Experience with Pulverised Fuels and Lump Brown Coal...	12 10
832	Stationers' Sundries, Incorporating Drawing Pins, Lever Arch Letter Files, Manilla Files, Perforators, &c.	2 8
836	German Light Metal Industry (Fancy Goods)	2 2
845	Constructional Details of Chlorine Plant at Hoechst and Gendorf...	2 8
898	A Note on the Influence of Nitrogen in Steel...	0 7
899	De-Icing and De-Misting of Aircraft Windscreens: Investigation of German Electrically Heated Windows	1 1
916	The German Mineral Wool and Heat Insulation Industries ...	3 8
940	Ruetgerswerke, A.G. Castrop-Rauxel: Tar Distillation ...	2 2
274 (Addendum)	Technical Developments in German Margarine Industry: Analysis of Samples	0 3

B.I.O.S. Information Section, 37, Bryanston Square, W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

A North Downs Orbital Road

Last week the Surrey County Council considered some objections raised by various interests to the proposed south orbital road, which will run between Egham Bridge and Titsey, near the Kent boundary, and pass to Shoreham and Swanley. The Highway Committee of the Council stated that while it was mindful of the fact that a route on the North Downs would encroach upon some open spaces, it felt that a new road suitably sited and carefully laid out on parkway lines would not detract from the amenities of the district. It therefore recommended the approval of the original North Downs route, with amendments designed to meet objections made in the interests of agriculture and amenities. The route as now proposed will run from Egham and pass between Thorpe and Virginia Water to the Chertsey road. From thence it will run via New Haw and Byfleet, over the existing Ockham Common road, and north of Great Bookham Common to Fetcham. It will then skirt Kingswood, Merstham, Godstone, Oxted and Westerham, and will then finally pass in a north-easterly direction to Chevening, Shoreham and Swanley. In the amended route the proposed road passes a greater length of Walton Heath than in the original plan. The cost of the whole scheme is to be about £6,000,000. An alternative route south of the North Downs would cost £505,000 more than that proposed while another alternative route south of Reigate and Redhill would cost £465,000 more. The Council approved the Highway Committee's recommendation.

The Institution of Civil Engineers

H.R.H. The Princess Elizabeth visited the Institution of Civil Engineers on Wednesday, July 30th, to receive the diploma of her Honorary Membership, to which she had been elected recently and signed the roll of Honorary Members. She was welcomed by the President, Sir William Halcrow, and Sir Roger Hetherington, President-Elect; Sir John Thornycroft and Sir Peirson Frank, Past-Presidents; Dr. E. J. Hamlin (South Africa) and Mr. W. H. Morgan, representing the Council, and Mr. E. Graham Clark, secretary. Before leaving, the Princess made a tour of the Institution and in the library was shown some examples of work carried out by civil engineers in the past and works proposed for the future. The association between the Royal Family and the Institution, which originated in the election of the Prince Consort in 1843, and which has been continued since 1865 by the election of each successive heir to the Throne will thus be maintained by the election to Honorary Membership of her Royal Highness.

British Waterworks Association

The authorities responsible for public water supply throughout the country have for some time past felt growing concern with regard to the effect which the existing short supply of every sort of material and necessary equipment and all essential chemicals is likely to have upon the maintenance and extension of water supplies both for domestic consumption and for industry. Water undertakers have hitherto succeeded in overcoming the difficulties arising from these shortages and have been able to meet the demands made upon them by drawing upon stocks of material accumulated for emergency purposes during the war, by recourse to improvisation and by other makeshifts. Existing stocks are, however, rapidly becoming exhausted and the scope for further improvisation is clearly limited. A situation is thus developing in which the possibility of a partial failure or curtailment of water supplies can no longer be ignored. Nor can it any longer be assumed that the supply of water to new housing projects will necessarily keep pace with development. Furthermore, the completion of works intended to augment available supplies over a period of years must now obviously be delayed. The British Waterworks Association, representing the water undertakers of the United Kingdom, has recently discussed this situation with officers of the Minister of Health. It is satisfied that the Minister is fully alive to the urgency and seriousness of the position and is ready to do whatever lies within his power to assist them in their difficulties. It has, however, been made clear that, whilst measures for coping with the present difficulties of individual undertakings will, as far as possible, be forthcoming, no general improvement of the present situation can be expected until the existing shortages of materials and equipment are obviated.

The Late Mr. E. W. L. Gardner

In our last week's issue we recorded briefly the death, on Saturday, July 26th, of Mr. Eric William Lawrence Gardner, at the early age of fifty-six. Mr. Gardner was a director of L. Gardner and Sons, Ltd., of Barton Hall Engine Works, Patricroft, Manchester, and was managing director of the firm's selling organisation, Norris, Henty and Gardners, Ltd. In common with all the members of the Gardner family, he served his time in the works and used to clock in at 6 a.m. with other employees. He was, on completing his training, given charge of the progress department. During the whole of the 1914–1918 war he served in the Army and was given commissioned rank shortly before the end of that war. In 1934 he was appointed commercial director of the company, and in recent years he devoted practically all his time to the administrative side of the company's work, rather than to the technical side, and had taken a leading part in the sales organisation of the firm. Both in his business life and private life, Mr. E. W. L. Gardner was greatly respected by all with whom he came in contact. His sincere interest in the welfare of others stamped him as a man who was always approachable and considerate. News of his death was learned with deepest regret by many employees of the firm, who had begun their annual holiday the previous evening, and some 300 of them, along with many of his colleagues, attended his funeral on Thursday, July 31st, last week.

Highway Maintenance

On Wednesday, July 30th, Mr. Alfred Barnes, the Minister of Transport, received a deputation from the British Road Federation on the matter of road maintenance. The deputation was led by Mr. Gresham Cooke, M.A., of the Society of Motor Manufacturers and Traders, and consisted of Mr. W. P. Andrews, B.E., A.M. Inst. C.E., of the Cement and Concrete Association; Mr. H. M. Lewis, A.M. Inst. C.E., of the Limestone Federation; Mr. R. A. B. Smith, A.M. Inst. C.E., M.I. Struct. E., of the Road Haulage Association; and Mr. A. G. Wright, of the National Farmers' Union, with several members of Parliament. The deputation deprecated the recent decision of the Government calling upon highway authorities to reduce their estimates for highway maintenance, with a consequent reduction in grants. This was regarded by the British Road Federation as a retrograde step. It was felt that this policy had been embarked upon without due consideration of the economic loss which will inevitably be borne by the general public, through handicaps placed on road transport, the depreciation of vehicles and the accelerated depreciation of the capital invested in our roads. The deputation accordingly asked the Government to return to its original policy and implement the first stage of the ten-year plan, announced by the Minister in 1946. After a general discussion had taken place, the Minister said that the representations made by the deputation had his sympathy, but it would be too much to hope that the roads could escape altogether the effects of the general economic situation. He claimed that he had not gone back on the ten-year plan, and he looked upon the present period rather as an interruption. When the circumstances were appropriate, he promised he would do all he could to overtake arrears in the operation of the plan. He reminded the deputation that several schemes, such as the Severn bridge and the Jarrow tunnel projects, were going forward.

Supplies and Services (Transitional Powers) Bill

As we go to press, the Supplies and Services (Transitional Powers) Bill is being debated in Parliament. The Bill, which was presented in the House of Commons by the Prime Minister on Tuesday last, is intended "to extend the purposes of the Supplies and Services (Transitional Powers) Act, 1945." This Act, it may be recalled, empowered the Government to continue for five years after the war certain Defence Regulations which could be made applicable to the continuance of economic controls during transition to a peace economy. The purposes for which such Defence Regulations were to have effect under the Act were as follows:—To secure a sufficiency of those supplies and services essential to the well-being of the community, or their equitable distribution, or their availability at fair prices; to facilitate the demobilisation and resettlement of persons and to secure the orderly disposal of surplus material; to facilitate the readjustment of industry and commerce to the requirements of the community in time of peace; and to assist the relief of suffering and the restoration and distribution of essential supplies and services in any parts of His Majesty's dominions or in foreign countries that are in grave distress as the result of the war.

Atomic Energy Research Station Progress

In one of our notes published in last week's issue we made reference to the establishment of a new atomic energy plant at Sellafield, in Cumberland, and the parts to be played in the general scheme by the Ministry of Supply factory at Springfields, near Preston, and the Atomic Energy Research Station at Harwell. In reply to a question in the House of Commons, as to whether the Minister of Works was satisfied with the progress of the building work at Harwell, Mr. Key said that a number of factors had contributed to setting back the work, as compared with the programme which had been originally arranged. It was necessary, he pointed out, in order to avoid injuring local housing programmes, to build up a large imported labour force. The Harwell project, he went on to say, had suffered in common with all other building construction and more heavily than most, from the difficult weather conditions of last winter, while the novelty of the project had introduced other elements of difficulty and delay. He was satisfied with the present position, and Mr. John Wilmot, the Minister of Supply, shared, he understood, his view that the work at Harwell was making good progress. He was satisfied that the contractors, the sub-contractors and the Ministry of Works staff were giving of their best. It is explained by the Ministry of Works that some of these research buildings must be constructed with an accuracy measured in thousands of an inch, while the precautions necessary to ensure the health and safety of the research staffs entail an elaboration of finish which in many cases is higher than that required in constructing an operating theatre. In the third report of the Select Committee on Estimates published by the Stationery Office on Tuesday, August 5th, concern is expressed at the rate of progress of the Harwell Research Station. The Committee has gained the impression that the rate of progress could be substantially increased. It recommends that an immediate independent inquiry into the organisation of this work should be instituted.

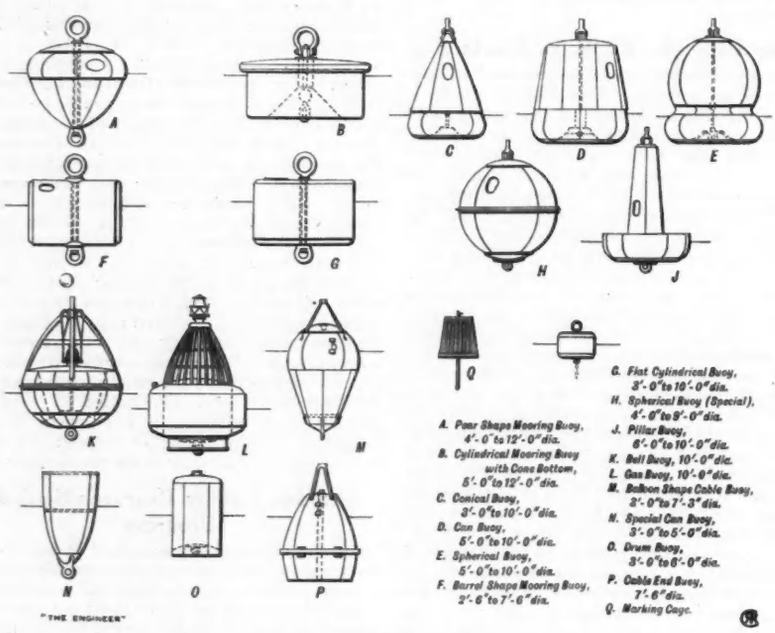
Lighthouse Engineering

By K. C. SUTTON-JONES, Stud. Inst.C.E.

No. V—(*Continued from page 96, August 1st*)

IN turning our attention to buoys we commence to examine the "Street Lamps" of the sea, for they mark out the lanes along which shipping must ply to reach safe anchorage.

The presence of obstructions, forks, wrecks and islands of mud and sand (officially known as "middle grounds") are also indicated by means of buoys, many of which carry lights and some of which carry bells or whistles. Principal changes of direction are usually indicated by lightvessels.


A
B
C
D
E
F
G
H
J
K
L
M
N
O
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Q
A. Pear Shape Mooring Buoy, 4'-0" to 12'-0" dia.
B. Cylindrical Mooring Buoy with Cone Bottom, 5'-0" to 12'-0" dia.
C. Conical Buoy, 3'-0" to 10'-0" dia.
D. Can Buoy, 5'-0" to 10'-0" dia.
E. Spherical Buoy, 5'-0" to 10'-0" dia.
F. Barrel Shape Mooring Buoy, 2'-6" to 7'-6" dia.
G. Flat Cylindrical Buoy, 3'-0" to 10'-0" dia.
H. Spherical Buoy (Special), 4'-0" to 8'-0" dia.
J. Pillar Buoy, 6'-0" to 10'-0" dia.
K. Bell Buoy, 10'-0" dia.
L. Gas Buoy, 10'-0" dia.
M. Balloon Shape Cable Buoy, 2'-0" to 7'-3" dia.
N. Special Can Buoy, 3'-0" to 5'-6" dia.
O. Drum Buoy, 3'-0" to 8'-0" dia.
P. Cable End Buoy, 7'-6" dia.
Q. Marking Cage.
"THE ENGINEER"

FIG. 17—SOME TYPICAL BUOYS

Systems of channel demarcation vary from one country to another, but in this country conically-shaped buoys mark limits to starboard when entering an estuary from the sea; those marking limits to port are can- or flat-topped in shape, whilst the presence of "middle grounds" is indicated by spherically-shaped buoys. Starboard and porthand buoys are painted in separate colours, whilst spherical buoys bear white horizontal stripes. Green buoys with the words "wreck" in white letters on the side indicate the presence of sunken obstructions and isolated obstructions and special positions are guarded by pillar-buoys, which have a tall central structure. Identification of buoys is further facilitated by daymarks (consisting of slatted wooden or steel cages of characteristic shape) surmounting the buoy shells. Estuary buoys are also numbered so as to give an indication to the pilot of distance from the bar or dock. Important channels are marked by chains of lighted buoys, and much ingenuity has been exercised in their construction and equipment.

The buoy shell is constructed of iron or steel plating at least ¼in in thickness and although it has been customary to rivet the plates together in the past, welded construction is proving cheaper and satisfactory, and where the shell itself constitutes the gas reservoir, welded construction is deemed essential, since riveted joints tend to leak after time has elapsed. Special measures are taken to minimise corrosion; two methods being the vulcanisation of the plating and painting with rubber or tar-paint.

Various standard sizes of buoys are employed according to site conditions (see typical illustrations, Figs. 17 and 18). These particular buoys were made by Fraser and Fraser, Ltd. Those in deep water are constructed with "tails," balance weights and often rudder fin, whilst those in tidal estuaries are usually flat-bottomed so as to allow the buoy to "sit" on the bed at low tide. The standard sizes laid down by the Trinity House authorities classify buoys in five groups. The largest type measures 12ft in diameter and weighs some 4 tons; the smallest buoys measure 5ft in diameter and weigh about 2 to 3 tons. Gas-lighted buoys weigh from 4 to 9 tons.

Concrete sinkers varying in weight from 40 to 50cwt are extensively employed for mooring buoys. Other forms of anchor are the umbrella, stock and screw types. The mooring chains are 1in to 1¼in in diameter, and vary in length according to the depth of water—usually from two to two and a half times the depth of water beneath the buoy. Anchors are usually in pairs or "fours," the main chain being joined to the anchors by two or four subsidiary chains.

A development of the buoy is the boat-beacon, which is a small, unattended light-vessel—there being many in service in the Mersey Estuary. The most common type comprise a boat-shaped "float," some 35ft in length and containing the gas cylinders, upon which is mounted an openwork structure and lantern—a clapper-bell being supported within the structure.

Illuminants now generally employed in buoys and beacons include kerosene, oil, gas, blau gas, propane, acetylene, and electricity. Pintsch oil gas is stored at 90 lb to 105 lb per square inch pressure. Blau gas is readily transportable although it is more expensive to produce than oil gas. Propane is used extensively in the Low Countries whilst acetylene has been almost universally adopted especially in its dissolved form. Two types of buoy employing acetylene as illuminant are in service. One type contains a complete acetylene generator, but is fast giving place to the dissolved system, where gas is stored aboard the buoy in standard-sized bottles—there being special pockets within the buoy shell to accommodate the bottles. This latter method is further preferred on account of the special care required in ensuring a certain standard of purity in the gas generated. The bottles comprise steel containers filled with a porous mass and a quantity of acetone which absorb the acetylene. Thus charged, the explosion hazard is obviated and it is customary to employ a pressure of an equivalent of 15 atmospheres. Pockets are usually provided for at least two cylinders (many buoys contain five cylinders) and, with the shorter periods of flashing, many months of gas supply are thus provided and the buoy remains unattended during such periods. In most cases buoys "flash" continuously for such periods, it not being considered economical to extinguish the light during

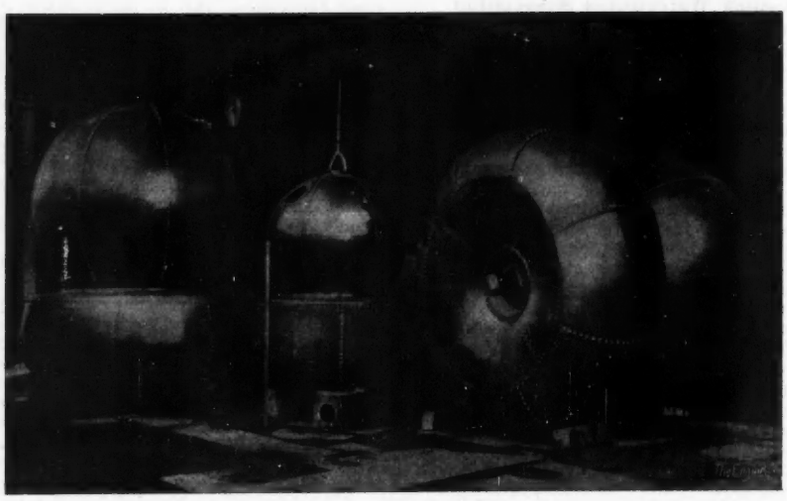

FIG. 18—BUOYS UNDER CONSTRUCTION

daylight, in view of the small gas consumption saved. Where large burners or fixed characters are involved, the installation of a light-sensitive valve is warranted, however. The light-sensitive valve for kindling and extinguishing automatically has thus solved the problem of the unattended beacon, and two notable examples of such valves are the A.G.A. sun valve and the "Chance" light valve, whilst photo-electric means are now coming into use. Both the A.G.A. sun valve devised by Gustav Dalen, of Sweden, and the "Chance" light valve operate on the principle that upon exposure to light a dull black or non-reflecting surface will become appreciably higher in temperature than a similar reflecting or transparent surface. In the A.G.A. sun valve the difference in the expansion of

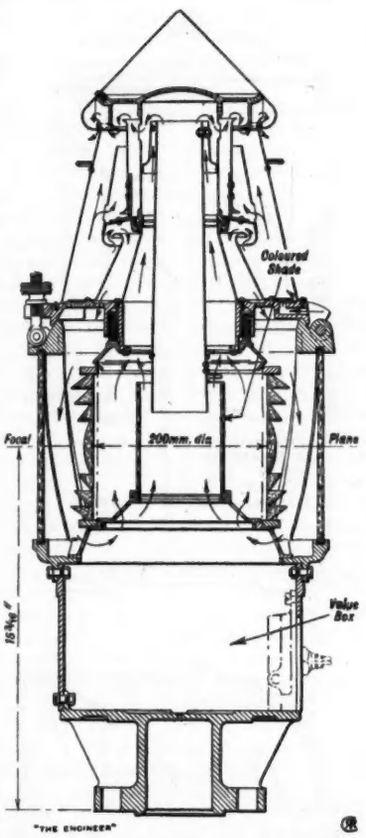

FIG. 19—200MM ACETYLENE LANTERN

blackened and burnished rods is magnified so as to operate a valve, whilst the movement in the "Chance" light valve is obtained by the change of head of liquid ether contained in clear and blackened glass bulbs. In the latter type the difference in temperature within the bulbs causes ether to vaporise in the one and to condense in the other, which causes the cradle supporting the bulbs to tilt, thus operating the gas valve.

Both types of valve have proved equally serviceable, and may be employed for gas or electric operation. They save from 20 per cent to 40 per cent consumption.

A typical acetylene installation comprises gas cylinders, regulator and flasher, burner, valves, pressure gauge, filter and piping. A regulator and a flasher of simple pattern have already been described (page 49), but, in general, the flasher is constructed to give a certain character which is adjustable within prescribed limits. Once set, the flasher assembly is capable of emitting gas to the burner in most precise measure and with uncanny regularity. Multiple and changeable characters are also catered for by the installation of multiple flasher assemblies—truly incredible results being achieved.

The gas is consumed either in open-flame steatite burners, of capacities ranging from 5 litres to 35 litres (single burners), to over 200 litres (in clusters)—or in incandescent mantles. The latter are usually of Ranie fibre, specially impregnated, and as their use calls for the inclusion of special gas-air mixers and other special apparatus, the application of mantle burners is mainly restricted to important beacon lights. The intermittent puffs of gas emitted by the flashers are ignited by continuously burning pilot by-pass jets, which consume an average of 10 litres of gas per day each. Bi-metal piping is employed for carrying the gas from the cylinders to the regulator and flasher—the latter being housed within the lantern in the case of buoys and small beacons.

Light emitted by the burners or mantle is condensed into the horizontal direction by means of a dioptric or catadioptric fixed lens. Lenses varying from 90mm to 500mm diameter are employed for buoys —special allowance in the design of the lens section being made to cater for the rolling motion which may be as great as 40 deg. in the open sea. The combined effect of the special lens and the height of the lightsource is to give a vertical divergence to the emitted beam of approximately 10 deg. Whilst ground and polished glass is still preferred for the larger lenses—it is now common to employ lenses of pressed glass also.

Lanterns for housing the lens, flasher and burners are elaborate in the case of gas illuminant—a typical section being shown in Fig. 19 (Chance Bros., Ltd.). Ventilation is a major consideration where acetylene gas is used since air-flow enough to prevent steaming of the glass and for aiding combustion of the gas has to be admitted without admission of sea water or spray. Lanterns of Trinity House design embody a most ingenious system of ventilating spinnings retained by an upper ring hinged to the glazing framework. A spring-loaded retaining ring is fitted to the upper ring for clamping the lens to the lower lens retaining spinning, into which latter fits a further spinning for supporting a coloured glass cylindrical filter or shade included where coloured light is to be emitted. Thus upon opening the roof, the lens and shade may be extracted and the burners attended to without difficulty. The glazing framework in this type of lantern is helical, but Fig. 20 shows another type (Gas Accumulator Co. (U.K.), Ltd.) in which the obstruction caused by each vertical glazing bar is ingeniously compensated by diverging light obstructed by one bar into the direction obstructed by the neighbouring bar. This is achieved by the inclusion of vertical glass prisms behind the vertical bars.

In preceding articles we have dealt with acetylene only in connection with stationary optical apparatus. It is not to be concluded, however, that the application of acetylene gas terminates here, since it is also possible to rotate optics by means of gas pressure. The power of revolution is obtained from a modified flasher, which oscillates a ratchet "pecker" arrangement which, in turn, rotates the optic and table. Gas pressure is further employed to operate bells, &c.

Reliable as gas-operated buoys have proved to be, considerable difficulty is often encountered in the changing of gas cylinders at sea. The usual practice with small buoys is to hoist the buoy bodily upon the deck of the servicing vessel for changing the cylinders and then to refloat it. Furthermore, it is often necessary to send the gas cylinders a considerable distance in order to effect a recharge of gas. Less cumbersome equipment has been introduced for operation off dry and wet batteries. Lead-acid and nickel cadmium batteries are employed—it merely being necessary to have an electric supply to effect a recharge, and dry batteries may be stored ready for use and scrapped afterwards. The use of electricity has the further advantage over gas lighting in the simpler forms of lantern employed, since the complex ventilation spinnings are not required for electric lights and the very important upward indication to large vessels at close range can be arranged without difficulty.

Prefocus type low-voltage filament lamps are employed, the rating being from about 3W to 60W. Messrs. Wallace and Tiernan, of America, are well known as pioneers in small battery-operated buoy and beacon

FIG. 20—300MM ACETYLENE LANTERN

equipment and have developed this branch of marine lighting considerably. In any equipment of this nature operational drain of the battery is the critical factor. The American apparatus includes a small d.c. motor for providing the flashing character, and lamps are over-run by about 15 per cent, which, although limiting the life of a lamp considerably, increases beam intensity. To safeguard against lamp failure, a lamp changer is provided. There are arguments in support of this and also of the fact that when the battery approaches its limit of discharge the voltage per cell drops and the beam intensity drops also.

Chance-Londex, Ltd., British makers of electric buoy lighting equipment, operate the lamps at rated voltage and employ an all-steel battery having negligible internal discharge, thus maintaining uniform intensity and using the full normal life of the lamp. Chance-Londex buoy lighting equipment was developed during the war, when Messrs. Londex devised a means whereby buoys, whilst having their independent sources of electricity, could be switched on and off from stations ashore without the use of cables to the buoy. This was necessary so that buoys could be extinguished upon approach of enemy aircraft.

In order to give long unattended operation of the buoy it was necessary to develop a

flashing mechanism which consumed negligible electricity. This was done by Messrs. Londex, and has been perfected with great success to the benefit of post-war marine lighting. The flashing mechanism embodies a photo-electric night/day switch and long periods of operation off the battery supply are obtainable.

The optical system employed with Chance-Londex apparatus is of interest. One of the principal objections to electrically operated apparatus has been the small amount of vertical divergence in the beam from a lens employing a small filament light source. Thus, when the buoy tosses in heavy sea the light flashing character is disturbed. To overcome this the British makers have devised a pendular support for the lens and also provide a beam divergence of plus and minus 7½ deg. Furthermore, the lens is the lantern as well, because the lens section is finished with a glass top, whereby the important upward indication to vessels when "on top of" the buoy is given. The absence of lantern astragals is an important feature also, and fouling of the glass top is prevented

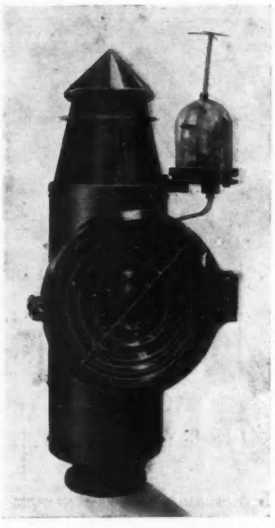

FIG. 21—ACETYLENE RANGE LIGHT

by a wire bird-scarer surmounting the lens. A battery consisting of two 95 lb banks of nickel-cadmium cells will in most cases provide at least six months' unattended operation. The entire equipment is housed in watertight compartments and is of robust design and construction.

The change over to electrically operated apparatus for use at pierheads and harbour entrances is a gradual process and, as yet, most are oil-burning. A definite bid to improve these conditions has been made with the introduction of a new marine portlight or beacon of Chance Brothers design. This portlight comprises a pressed-glass lens 250mm in diameter, lantern mounting, automatic lampchanger and switch gear. The lens is designed so as to give a horizontal beam from the upper portion of its section and a fan beam to the near-sea regions from the lower portion. This latter provision is particularly useful when navigating at close quarters in thick weather. The lantern is of non-ferrous metal throughout, and so arranged that light emitted from the lens is uninterrupted in any one azimuth. The lampchanger operates electromagnetically—the trip mechanism operating instantly upon main lamp failure. Luminous ranges of up to thirteen miles are obtainable with this portlight (during clear weather conditions), the lamp wattage employed being up to sixty—the lamps operating off a 12-V or 24-V supply stepped down from line-voltage by an air-cooled transformer. It is thus an easy matter to arrange for a standby battery supply, which is brought into operation instantly should mains failure occur.

Another type of unattended apparatus receiving wide application in the Far East comprises an optical system of fixed section which incorporates an electric filament lamp in the main lamp position of the lamp-changer, and an electric lamp of reduced power in the standby position. At nightfall the main lamp and Londex flashing mechanism are connected automatically to a battery. At daybreak the apparatus is disconnected and an engine generator battery charging set is started automatically. This shuts down upon the battery being recharged. If the main lamp fails during the night, or if at daybreak the engine generator set fails to recharge the battery, the lamp changer brings the standby lamp into focus automatically and this lamp, being of reduced power, will operate for a further fifty duty periods off the remaining capacity of the battery. Furthermore, the reduced beam intensity is a warning that the light must be serviced within the next month or so. Beam intensities of up to 30,000 candles (white) are obtainable with this apparatus.

When ships are groping either into estuaries or along channels, it is often necessary to indicate a channel's course or a turn, &c., by means of placing two or more beacons in line. These are known as leading beacons—many of which are lighted. The day-marks—which may be of any predetermined distinctive shape—are mounted on towers placed some distance apart. In many cases lights surmount the towers and their erection entails quite a complexity of considerations. It will be obvious that the rear tower must be higher than the forward tower and the difference in height is determined by the distance separating the towers and the distance into which the "lead" has to be followed. The distance separating the towers is dependent upon the distance between the forward tower and the area in which the ships commence to use the "leading." Generally speaking, the principle involves the location of the forward light and then manœuvring until the rear light appears in line with the forward light, and then keeping on the course. Thus, it is necessary to employ a fairly wide arc, and in some cases coloured sectors, to the forward light for locating purposes, whilst the angle of the rear light is determined by the margin of deviation permissible from the line of lead. This precise horizontal divergence is obtained by employing a holophotal lens with a narrow lightsource. The lights are distinguished either by colour or by flashing characteristics and many ingenious systems of colour sectors, &c., have been devised. In certain cases a combined fan-beam and holophotal-beam apparatus is employed, but where distant indication is required the parallax method, with towers, is to be preferred. Figs. 21 and 22 (Chance Bros., Ltd.), show two types of range (or rear) leading light as described above—one for acetylene complete with "Chance" lightvalve and one for electric operation. The latter is used in conjunction with the marine beacon described above. The acetylene and electric types are similar in optical principle in that the light emitted by the lightsource is condensed into the required direction by a holophotal lens. The light radiating behind the lightsource is reflected by means of a special mirror fitted at the rear of the housing.

Prior to the introduction of electric light-sources, it was found necessary to employ large optical apparatus for leading lights, which required large towers—each housing attendants. Luminous ranges in excess of ten miles are now obtainable from remarkably small lights, which require only light openwork or column structures for support.

A system which has been adopted widely in Eastern waters is the Wigham Automatic Beacon, which consumes well refined petroleum. The oil reservoir forms the base upon which the lens and lanterns are supported. One or three wicks are employed, according to the size of beacon, but instead of the wick

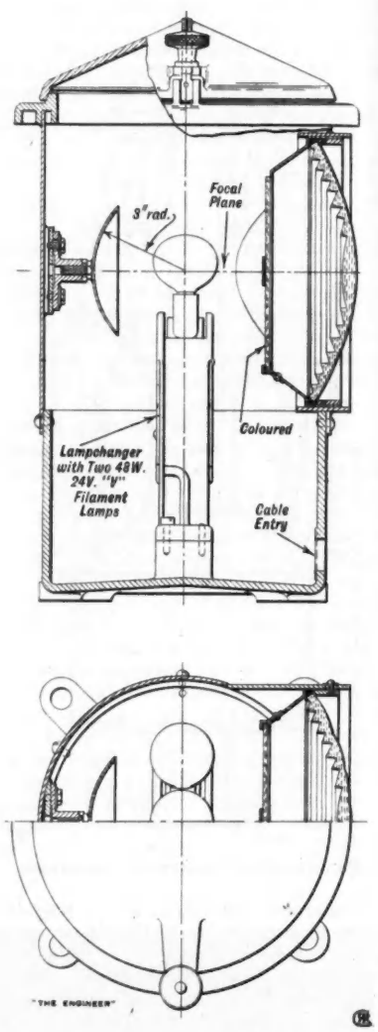

FIG. 22—ELECTRIC RANGE LIGHT

being burned at its end—the flame is delivered from the flat side, which ensures a minimum of carbonisation and constancy of flame. A separate cylinder contains a float, which is supported on oil. A micrometer valve allows the oil to drip from the cylinder at a certain speed. The wick passes over a roller and is attached to the float, which effects the wick feed as the oil drains from the cylinder. The cylinder oil may be used over and over again, and this type of beacon, manufactured by Edmundsons, of Dublin, is regarded as being an efficient and reliable oil-burning light.

It is interesting to note that white and coloured reflectors are fitted to some un-

lighted buoys and beacons (particularly in the United States), which reflect searchlight beams, thus making them discernible by ships at night. Radar reflectors are now having application to buoys.

The sound signal of widest application to buoys is the bell (weighing from 3cwt to 6cwt). Bells are struck either by clappers actuated by the rolling motions of the buoy or by mechanical means. The great drawback with the swell-operated clapper bell is the fact that during fog—when the bell is most useful—the sea is usually calm! Carbonic acid gas and compressed air and even tidal action are in use for operating bells aboard buoys and submarine bells are also employed to a limited degree. A popular mode of noise-making for buoys is to fit a central tube which descends some 15ft to 20ft into the water. At the upper end of the tube is fitted a whistle. Air becomes compressed within the tube under the action of the swell and blows the whistle. This sytem suffers from the same drawback as the clapper bell, but has had wide application, especially in important locations.

The electrical principles adopted on beacons and portlights vary considerably according to local circumstances, but, generally speaking, lights are becoming less attended and more automatic in operation. Many stations now employ light valve or time-switch control for automatically switching on and off, whilst the employment of lamp-changers, automatic change-over systems to standby battery supply, &c., are taking the place of oil-burning installations. Special care has to be taken, however, in the choice of suitable lamps when electrifying existing optics, which may have been focused on a cylindrical and not a point source when manufactured. The adoption of pearl lamps is found desirable for increasing divergence in the beam, but where coloured sectors are employed—clear narrow filaments are essential so as to maintain horizontal divergence (and, therefore, angle of change between colours) at a minimum. A wide divergent sector is a danger in that the point of "cut" between the colours is not precise. Where very small apparatus is employed, however, it is occasionally found desirable to fit "cut-off" shields to the outside of the lantern. These shields are merely vertical metal plates mounted radially to the centre of the lens and effectively reduce the indefinite arc of perception caused by divergence in the beam. A further difficulty often to be surmounted is the installation of suitable electrical equipment within an old lantern. Many such lanterns are polygonal in plan and feature broad, vertical glazing bars. To overcome this it is necessary either to employ a revolving optic or a fixed optic with some means of diverting light into the directions obscured by the bars. To provide a lightsource of adequate width is sometimes impossible.

Colours for harbour lights and beacons are undergoing a change. Red and green are the only satisfactory colours from the perception standpoint, and generally speaking, the transmission of light through such glasses is in the order of 20 per cent (compared with white light transmission). Yellow is unpopular on account of its being mistaken for a "foggy" white or oil-burning "white," whilst blue is of very poor transmitting property (2 per cent).

Petroleum vapour and oil-burning portlights are still employed extensively, although they are gradually giving place to those operating off electricity and acetylene gas.

Fog signals for harbour installations are mainly confined to pneumatic reeds and diaphones, and to electrically vibrated oscillators operating at a higher frequency than air signals. The smallest type of diaphone piston for harbour installations is so small as to be held within one's hand and yet, together with the cylinder, &c., it produces sound of some 3 miles range. The power equipment for such signals is quite small and may be operated automatically or remotely under radio impulses.

To the onlooker, the harbour light is "just a light"; to the initiated it can spell great achievement, for contained within the "lantern and box" at the summit of the column is reliable mechanism for ensuring a safe and dependable aid to the navigator.

(To be continued)

Powder Metallurgy

No. IV—*(Continued from page 108, August 1st)*

WE continue our report of the Symposium with an account of four papers dealing with hard metal carbides.

Hard Metal Carbides

At the morning session on Thursday, June 19, 1947, the chair was taken by Col. P. G. J. Gueterbock, C.B. (President of the Institute of Metals), and J. C. Sykes presented the following papers of :—

Section D.—"Hard Metal Carbides": (11) "The Preparation of Carbides," by L. D. Brownlee, G. A. Geach and T. Raine; (12) "The Manipulation and Sintering of Hard Metals," by H. Burden; (13) "The Physical Metallurgy of Sintered Carbides," by E. J. Sandford and M. Trent; (14) "The German Hard Metal Industry," by G. J. Trapp, B. E. Berry, H. Burden and T. Raine.

Dr. C. Sykes, F.R.S., introducing the four papers, said that the first, by Mr. Brownlee, Dr. Geach and Dr. Raine, dealt with the preparation of tungsten carbide, titanium carbide, the mixed carbide, and also of tantalum carbide. The production of tungsten carbide using the high-frequency furnace and a mixture of carbon, lamp black and tungsten called for no special comment. The production of titanium carbide was a relatively more difficult matter. To produce titanium carbide, free from oxygen, they had to operate at a temperature up to 1950 deg. Cent. in a relatively high vacuum. The preparation of the powder—that is, the titanium oxide and carbon—had to be carried out properly before the heat treatment. A similar process for the production of tantalum carbide was a somewhat simpler one on a commercial scale than that for titanium carbide, since the heat of reaction was somewhat smaller.

A vacuum process for treating suitable mixtures of titanium and tungsten carbide was described, and data given on the solubilities of tungsten carbide in titanium carbide and titanium carbide in tungsten carbide. The solubility of titanium carbide in tungsten carbide was quite small, whereas the solubility of tungsten carbide in titanium carbide was quite high. Finally, the authors described the preparation of the final mixed powder, tungsten carbide, titanium carbide and cobalt, and emphasised the importance of the correct milling of these powders. Dr. Sykes thought that this ball milling operation was not particularly well understood, and found it quite difficult to see how the grain size of a powder could be actually broken down in a ball mill, where one must be dealing with a very sluggish motion of balls through what was, in effect, a very viscous fluid.

Mr. Burden in his paper dealt with the manipulation of the powder from the stage of the final mixing to the production of the final tip, and discussed the four operations concerned—pressing, presintering, shaping and sintering. The main points of interest in this paper were (*a*) the fact that the pressure applied to the compacts was relatively unimportant, and (*b*) the need for accuracy in the control of the grain size of the powder in order to finish up with the correct dimensions. A good control of dimensions is particularly important in the case of these hard carbides, because the only method of adjusting the dimensions of the final sintered tip is, of course, by grinding. Mr. Burden also emphasised the necessity for very careful control of the carbon-oxygen balance in the powder. That was also referred to by Dr. Sandford and Dr. Trent, who dealt with the physical properties of the carbides, and described in some detail the various things which took place in the pressed compact during sintering. An interesting point to which they referred was the very large grain size of the cobalt powder. He thought that the fact that the grain size was of the order of 1mm was first brought out during the war, and the National Physical Laboratory did a good deal of work on that aspect of the matter. The authors attributed the angular shape of the tungsten carbide grains to the precipitation of tungsten carbide from the cobalt matrix during the cooling operation. It would be interesting to have a similar description given for the structure of the tip containing mixed carbides.

The authors then described experiments on the rather complex equilibrium diagram associated with this class of alloy, and concluded that a deviation of more than 2½ per cent from the theoretical carbon analysis led to one or other type of defect. With too much carbon there was a tendency for graphite to be deposited. The authors felt that this was not very important, except in special cases, whereas Mr. Burden, who referred to the same thing, found it objectionable. When carbon was too low the so-called η-phase was formed, giving a peculiar cored type of tip and some brittleness in service.

Dr. Sandford and Dr. Trent recorded densities very near to the theoretical values (indicating that the porosity of these materials in production was very small indeed) very high compressive strengths (from 250 to 400 tons per square inch) and a high modulus of elasticity. They referred also to something which they called the inherent grain size as being very important in connection with the quality of the powders and the final tips, and this, he thought, called for some further elaboration.

The fourth paper dealt with a visit to Germany to examine the technique of the German carbide industry. The name of Mr. A. E. Oliver, of Hard Metal Tools, should be added to the list of the authors of this paper. The Germans had had so many problems of a technical nature associated with actual supply that they had not been able to spend as much time as would otherwise have been

the case on pure development work. The output of the German carbide industry was, of course, very large indeed, and they had had to use inferior methods of producing the powders simply because there was not enough hydrogen to deal with the quantity of material required.

The team singled out, as being among points of interest, the reduction furnaces used by Krupp for the production of tungsten powder, a special vibratory ball mill which was claimed to have rather special properties and a gadget developed by Krupp for the multiple hot pressing of tips from substitute mixtures. They described certain mixtures free from tungsten, consisting of molybdenum carbide, titanium carbide and nickel, which were used by the Germans as substitute materials, and which, according to the authors, were not very satisfactory. The Germans did a good deal of work on sintered alumina, but finally came to the conclusion that it was not really a satisfactory material. They also described the production of the diamond wheels for grinding, in which diamond powder was impregnated in tungsten carbide and nickel was also described.

Dr. Sykes thought that on the research side the main point of interest was the remark attributed to Dawihl in connection with the manufacture of the Widia Elmarid die, to the effect that the η-phase, which is such a nuisance in ordinary tips, could be used with advantage in the production of dies.

Towards the end of the paper there was a very abbreviated description of certain methods of using electrical conductivity and magnetic saturation which Krupps claimed could be used to give a good deal of information with regard to the properties of carbide tips. He thought that it would be very useful to have that particular piece of information elaborated, with a view particularly to seeing whether these methods could be applied to the examination of bodies of arbitrary shape ; in other words, could these electrical and magnetic methods be applied to tips, or must one have a nice round cylindrical bar.

There were one or two notable omissions. Nothing was said of the production of tungsten powder itself, except for the German practice, and nothing was said of the use of the hot pressing process in this country.

Discussion

Mr. R. Chadwick (I.C.I. (Metals), Ltd., Birmingham) said that as a member of one of the teams which had carried out some investigations on the German tungsten carbide industry, he was rather disappointed that no mention had been made of the very considerable use of tungsten carbide for projectile cores. He understood that the hot pressing technique, which was developed on such a considerable scale by Krupps, was developed very largely in order to be able to make the large quantities of tungsten carbide projectile cores which were required. The hot pressing process enabled the Germans to make use of scrap carbide—old cores and broken tips. He would like to know the authors' opinion of the hot pressing technique and how far they regarded it as mainly developed for these cores or mainly for use with the substitute carbides.

Mr. H. W. Pokorny (Chemo-Metals (London), Ltd., London), referring to the paper by Brownlee, Geach and Raine, said that without ball milling he had been able to get quite a satisfactory compact of normal hardness and structure, but that its grain size was much coarser. The interesting point was that after ball milling only for one or two hours, or perhaps three hours, the grain size dropped very considerably. He could give no explanation of this, but thought it was simply a question of mechanical disintegration of the carbide. There might be a certain amount of work hardening of the cobalt. It would be interesting to learn whether anybody else has made experiments in this direction.

Dr. J. C. Chaston (Johnson Matthey and Co., Ltd., London) directed attention to the statement by Sandford and Trent that the final stage in sintering was required to ensure freedom from porosity, and that the gas associated with central porosity was eliminated by being taken into solution in the liquid phase, with subsequent diffusion to the surface. He found it difficult to see why hydrogen which was in solution in a sintered carbide containing cobalt in which hydrogen is extremely soluble should diffuse to the surface in a hydrogen atmosphere. His alternative suggestion was that possibly the solution of the carbide in the cobalt reduced its solubility for hydrogen. In iron-copper compacts porosity was obviously one of the things which gave great trouble, but he knew of no evidence that heating an iron-copper compact for a long time would get rid of the porosity.

Mr. B. E. Berry (Murex Ltd., Rainham, Essex) wished to compliment the authors of the three papers dealing with methods of manufacture of carbide, but regretted the omission of reference (except briefly in the paper on German technique) to the hot pressing method. He thought that hot pressing in carbon moulds was a very important method in the production of tungsten carbide hard metal pieces, particularly as there was a tendency to try to produce bigger and bigger pieces of hard metal, and when that was done the hot pressing method becomes still more important. The hot pressing method as applied to tungsten carbide was not, perhaps, precisely the same as was understood by the metallurgists who deal only with the ferrous metals or the non-ferrous, non-carbide metals, in that it could be carried out and in fact always was, he thought, carried out in carbon moulds. The carbon mould is made to the shape of the finished piece and arranged so that all the shrinkage which occurs takes place in one direction only. It was possible, therefore, to hold the dimensional tolerances in all directions except the direction of pressing much more closely than was possible with the normal cold pressing methods.

The method of heating was by high-frequency current, or by passing the current directly through the mould or by a combination of two.

The question of hot pressing was one which vitally concerned the carbide industry, and any expressions of opinion from those concerned on the relative merits of high-frequency heating compared with resistance heating, or the combination of resistance and molybdenum furnace heating, would be of very great interest.

His own feeling was that if there was no particular reason for wanting to use the hot pressing method, then of the two he would prefer the normal cold pressing, unless it was essential to keep the dimensions to very strict tolerances. The carbon produced in this country, particularly in the bigger sizes, was not entirely suitable for use with the hot pressing method.

In Mr. Burden's paper there was a brief reference to granulation. He had found that when granulated powder was used for pressing it became necessary to apply a higher pressure than would be normal in order to be sure that the granules had been deformed and that the pressing was correct. Any information on that subject would be of interest.

Mr. H. M. Blyth (L. M. Van Moppes and Sons, London) stated that he had had to use hot pressing in the process with which he was connected, and had been hampered all the time by the fact that it had to be done in carbon, and that carbon would not stand heavy pressures. Any information about an alternative material or a better method of bonding the carbon would be of interest to those who had to use hot pressing. He had tried a mould made from zirconia refractory brick, but the surface was extremely poor, and it was no good as a substitute for carbon.

Mr. A. G. Metcalfe (Queen's College, Cambridge) drew attention to a discrepancy between the results given by different authors for the solubility of tungsten carbide in titanium carbide (those of Brownlee, Geach and Raine being low), and to the possibility of precipitation-hardening at the tantalum carbide end of the TiC-TaC system, where some precipitation on a fine scale seemed to have been observed by the authors. He inquired whether any of the authors were able to give any information on the existence of the various double carbides which had been claimed to exist.

Dr. E. A. Bano (Electro-Alloys, Ltd., London) asked whether the hot pressing method had been used to study equilibria under pressure. It might be interesting to investigate whether elevated pressure, above atmospheric pressure, would change the equilibrium diagram, and, if so, whether it would have any beneficial or detrimental result on the product.

Dr. D. J. Jones (G.E.C. Research Laboratories, London) referred to the difficulty of getting hydrogen with very low water vapour content, and of making a comparison between wet mixing and dry mixing. He was surprised that the iron pick-up from stainless steel ball mills was rather small, and asked the authors whether there was much chromium pick-up and what was the amount of wear with the stainless steel as compared with carbide, for example. He noted that pressures given for alloys sintered with a small amount of liquid present varied from 0·25 to 40 tons per square inch, and the only point that he would make on that was, why leave it at 0·25 tons per square inch. When a liquid phase was present you could sinter almost up to the theoretical density just with uncompacted powder.

Mr. Josiah W. Jones (College of Aeronautics, Cranfield, Bletchley, Bucks) said that the general engineering interest of sintered products seemed to him at the moment to be very limited. There was a hint contained in the paper by Sandford and Trent of improved Young's modulus. Nothing was mentioned about creep, but the authors quoted remarkably high compressive strengths, and the fact that the transverse strength was mentioned gave rise to faint hopes that there might be some possibilities also in tension. He would like to know whether any hopes at all were justified in that direction.

Dr. T. Raine (Metropolitan-Vickers Electrical Company, Ltd., Manchester), in reply, said that considerations of space had prevented them from dealing with the preparation of the tungsten powder ; but, as mentioned in the paper by Sandford and Trent, the grain size and grain shape of the tungsten powder used had a very important effect on the resultant properties of the carbide.

Dr. Sykes referred to the carbon/oxygen reaction during sintering as being extremely important. They had found that by a combination of vacuum and hydrogen sintering,

which is very simple to carry out, it is possible to control the rate of carburisation during sintering without any difficulty.

The chief point which had been raised so far as their paper was concerned was Mr. Metcalfe's point about the solubility of tungsten carbide in titanium carbide. The figures to which Mr. Metcalfe referred related to actual production batches weighing about 50kg, but they had found that by working with small quantities and compressing before heating they could obtain a solubility of 80 to 82 per cent of tungsten carbide in titanium carbide, as mentioned in the paper.

Reference had been made to the use of pure dry hydrogen. They found it very difficult to obtain dry hydrogen on a large scale, and therefore used the vacuum process.

As regards wet ball milling *versus* dry ball milling, he thought that it was agreed in the industry that wet milling gave a better product, and a product which was more free from porosity, than dry ball milling. With regard to stainless steel ball mills, they had used both stainless steel ball mills and carbide-lined ball mills. The life of the carbide-lined mills was several years. The stainless steel ball mills had been in operation now for about nine months, and there was still considerable life left in them. The iron pick-up after seven days' milling was of the order of 0·1 per cent to 0·2 per cent iron.

Mr. H. Burden (Brown-Firth Research Laboratories, Sheffield), in reply to Mr. Berry, said that granulation was not difficult. The process generally consisted of making a cake, either by adding wax in a solvent and driving off the solvent without disturbing the mix, which gave a loose cake, which could then be readily broken up by sieves and a granulating process carried out in a rotating container, for which an empty ball mill might be suitable; or alternatively, the waxed powder could be pressed into cakes and a similar procedure followed. The hardness of the granules depended on the pressure used, and it is certainly true that these had to be broken up effectively in the subsequent pressing. However, it was easy to see from the fracture of the pressed part whether these granules were broken up, and if slightly higher pressures were used there should be no difficulty in preparing a suitably granulated powder.

Dr. Jones raised the question of the compacting pressure, and asked why one should start at 0·25 ton per square inch, and why not admit that uncompacted powder would sinter satisfactorily. That would not be quite true; there was some limit to the voids which could be closed by sintering, and in a loose heap of powder there might be gaps which would not be satisfactorily closed by sintering. A very slight pressure was necessary to close them up, and a pressure of 0·25 tons per square inch was about the lowest pressure which could reasonably be used.

Dr. Raine disagreed with Brownlee, Geach and Raine in their statement that the carburisation of tungsten on a large scale could best be carried out in a high-frequency furnace. In a high-frequency furnace there was a big danger of overheating the outside of the charge before the centre was properly carburised, and there was likely to be considerable lack of uniformity of grain size in the material.

The solubility of tungsten carbide in titanium carbide reported by various workers seemed to be affected, as suggested by Dr. Raine, by grain size, and also by the presence or impurities. Traces of iron, nickel or cobalt caused much more rapid solution, and in production processes a small percentage of these metals was sometimes added to enable the solution to proceed more rapidly.

No mention had been made, in any of the work in this country, of any compound formed between tungsten carbide and titanium carbide. That was the experience of their own work; it seemed highly improbable that any such compound existed.

Dr. E. M. Trent (Hard Metal Tools, Ltd., Coventry), in reply, referred to the importance of maintaining consistent grain size which entailed the control of a very large number of factors.

They did not consider that graphite precipitation, if small in amount, was very important or that it had a big effect on the mechanical properties of the material. If the amount of graphite precipitated was excessive, it did, but the microstructure gave an exaggerated idea of the amount of graphite present.

With regard to the elimination of final porosity, it was quite likely that the hydrogen solubility was considerably affected by the tungsten carbide present in solid solution. He could see no other way in which the small amount of porosity at the centre of sintered pieces could be eliminated in the final stages of sintering than by solution of the gas—not necessarily hydrogen; it might be carbon monoxide—in the molten metal, and diffusion to the surface.

The question of the engineering properties of carbides of this kind was a very interesting one, but while they had some very unusual engineering properties (*e.g.*, very high Young's modulus, and extremely high compressive strength) they had certain poor properties as well, and in particular lack of ductility. Perhaps further research would improve, if not the ductility, at least the shock resistance of these carbides.

Questions had been raised on the other papers with regard to the preparation of the powders by ball milling and with regard to stainless steel ball mills. They found that pick-up of iron from stainless steel mills was very small, and they had had stainless steel ball mills in operation for ten years. On the question of milling, he thought that it was only to a minor extent a question of the breakdown of grain size: it was much more a question of the break-up of aggregates. There had been a suggestion that the carbide particles became coated with cobalt. Personally, he could not see how that could happen, and had not seen any concrete evidence of it.

He would particularly like to refer to the pioneer work which had been carried out by Brownlee, Geach and Raine on the preparation and sintering of carbides in vacuum at very high temperatures. This vacuum technique which they had developed seemed to him to have very important possibilities for the powder metallurgy industry, and he felt that the fact that it had to be carried out in batch processes was not necessarily a drawback.

Mr. B. E. Berry (Murex Ltd., Rainham, Essex), and Dr. T. Raine briefly replied to comments on the paper on "The German Hard Metal Industry," stating that further details would be found in the B.I.O.S. report of the trip, which was just about to be published.

(*To be continued*)

Internal Efficiency of Centrifugal Pumps and Compressors

By G. G. McDONALD, B.Sc., Ph.D.*

Introduction

THE changes that take place in the internal (*i.e.*, hydraulic) efficiency of centrifugal or axial flow pumps, blowers or compressors when the size of the machine and the kind of fluid being pumped are varied, are of importance in the prediction of the probable efficiencies of large pumps from the known efficiencies of geometrically similar small-scale models.[5, 6, 7, 8, 9, 10]

The object of this note is to set down, without proof, an approximate but rational formula for internal efficiency and to emphasise the importance of the "shock" coefficient especially in the case of pumps, for which the conditions of flow are not so stable as those for turbines.[5, 6, 7, 10]

The Hydraulic Efficiency

The internal efficiency e can be written:—

$$e = h/(h + h_s + h_f) \quad . \quad . \quad . \quad . \quad (1)$$

where, for unit mass of fluid delivered, h represents the total head gained, h_s the head lost through "shock," eddies, short-circuiting and leakage, and h_f the head lost in friction of the fluid against the surfaces of branches, passages, and impeller discs.

The efficiency can also be expressed,[5, 6, 7, 10]

$$e = 1/(1 + s + f r^a) \quad . \quad . \quad . \quad (2)$$

where s f and a are dimensionless experimental constants and r is the Reynolds' number $w/\mu d$ for the flow in the pump, $-w$ denoting the mass of fluid delivered per unit time, μ the coefficient of viscosity of the fluid, and d the diameter of the impeller.

The Shock Coefficient s

The shock coefficient s depends primarily on the "flow pattern coefficient" $w/\rho n d^3$, (where ρ is the density of the fluid and n is the rotational speed of the impeller) and to an almost negligible extent on the Reynolds' number. In geometrically similar pumps in which the respective flows are "geometrically similar" (*i.e.*, in which $w/\rho n d^3$, for the smaller machine equals W/PND^3 for the larger), s has the same value. When s attains its minimum value, e reaches its maximum or "optimum" value. To a slight extent, f also varies with $w/\rho n d^3$, but is the same for similar flows in similar pumps or compressors.

Surface Friction Coefficients

Experiments on the fluid resistance of the surfaces of pipes, rotating discs with small lateral clearances, and flat plates, indicate that a takes the value -1 for "viscous" flow, and approximately $-1/5$ for "smooth-turbulent" flow of the fluid relative to the surfaces. In "rough-turbulent" flow the resistance is independent of the Reynolds' number but depends on the "roughness" of the surfaces. This case is not dealt with

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in the present note, but references to it are given in the bibliography.[4, 5, 6, 7, 10]

A General Efficiency Step-up Formula

The so-called "efficiency step-up formula" for comparing the optimum internal efficiencies of "homologous" pumps and blowers follows from equation (2),

$$(1-E)/(1-e)=(s+fR^a)(1+s+fr^a)/(s+fr^a)(1+s+fR^a) \quad . \quad . \quad (3)$$

E representing the optimum efficiency of the larger pump for which the Reynolds' number R is W/MD, M being the coefficient of viscosity of the fluid in the larger pump. In the case of a given pump discharging different fluids, on different occasions, of course, E represents the optimum efficiency corresponding to the fluid and speed yielding the highest Reynolds' number R.

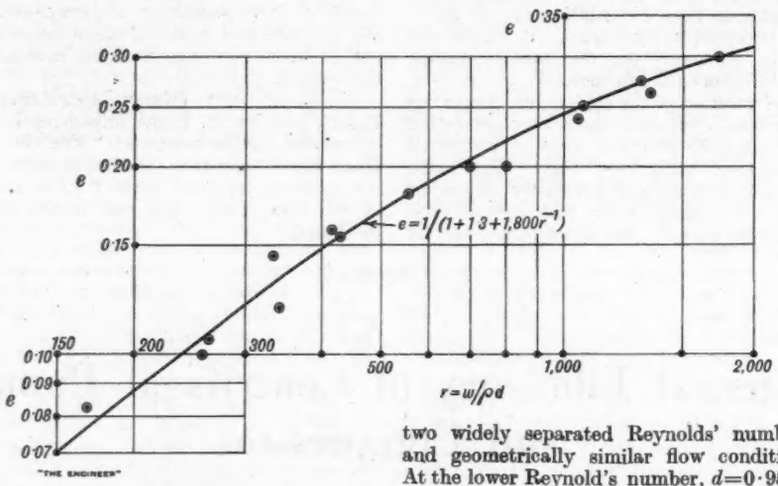
Calculation of f and s.

The presence and magnitude of the shock coefficient s can best be demonstrated by analysing a few test results from reliable sources. It can be shown from equation (3) that

$$f=1/e[r^a-(ER^a-er^a)/(E-e)] \quad . \quad (4)$$

and

$$s=e^{-1}-1-fr^a=E^{-1}-1-fR^a \quad . \quad (5)$$



ANALYSIS OF EXPERIMENTAL RESULTS ON CENTRIFUGAL OIL PUMP

Analysis of Experimental Results

Case 1.—Two geometrically similar single-stage axial flow propeller (water) pumps, type TA, were tested at approximately the same value of the flow pattern coefficient. ($w/\rho nd^3=W/PND^3$). For the smaller machine, $d=1\cdot865$ft, $e=0\cdot820$, and $r=1{,}100{,}000$. For the larger, $D=2\cdot75$ft, $E=0\cdot835$, and $R=2{,}260{,}000$.

Substituting in equations (4) and (5) noting that $a=-1/5$ for smooth turbulent flow, $f=2\cdot5$ and $s=0\cdot07$ approximately, indicating that for this design of pump the optimum internal efficiency can be expressed as

$$e=1/(1+0\cdot07+2\cdot5r^{-1/5}) \quad . \quad (6)$$

In this case, the "shock" loss is 7 per cent of the total delivery head. The surface friction loss is about twice the shock loss.

Case 2.—Two geometrically similar single-stage centrifugal (water) pumps, type TC, with split volute casings, were tested at approximately the same value of the flow pattern coefficient. For the smaller, $d=1\cdot01$ft, $e=0\cdot875$, and $r=581{,}000$. For the larger, $D=2\cdot94$ft, $E=0\cdot890$, and $R=1{,}587{,}000$. From equations (4) and (5) noting also that $a=-1/5$, $f=1\cdot6$ and $s=0\cdot03$, giving

$$e=1/(1+0\cdot03+1\cdot6r^{-1/5}) \quad . \quad (7)$$

In this design of pump the "shock" loss is 3 per cent of the total delivery head, and the surface friction loss is approximately three times the shock loss.

Case 3.—A nine-stage axial flow (air) compressor, type BE, was run at two widely separated Reynolds' numbers, with geometrically similar flow conditions. For the lower Reynolds' number, $d=1\cdot54$ft, $e=0\cdot865$ and $r=325{,}000$. For the higher, $D=1\cdot54$ft, $E=0\cdot870$, and $R=542{,}000$. Assuming smooth turbulent flow, $f=0\cdot94$, and $s=0\cdot08$, and

$$e=1/(1+0\cdot08+0\cdot94r^{-1/5}) \quad . \quad (8)$$

In this machine, the shock loss is 8 per cent of the total delivery head, and the surface friction loss is about the same as the shock loss.

Case 4.—A single-stage centrifugal (air) blower, type MD, with an extra large whirlpool and volute casing, was run at two widely separated Reynolds' numbers, and geometrically similar flow conditions. At the lower Reynold's number, $d=0\cdot953$ft, $e=0\cdot640$, and $r=25{,}400$. At the upper $D=0\cdot953$ft, $E=0\cdot665$, and $R=48{,}550$. For $a=-1/5$, $f=3\cdot8$ and $s=0\cdot06$, and

$$e=1/(1+0\cdot06+3\cdot8r^{-1/5}) \quad . \quad (9)$$

In this blower, the shock type of loss amounts to 6 per cent of the total delivery head, and the surface friction loss is about eight times the shock loss.

In the preceding cases, the flow conditions were smooth turbulent. In the next case, however, the conditions of flow were viscous, and $a=-1$.

Case 5.—A single-stage centrifugal (oil) pump, type MN, with volute casing, was tested at three speeds with five oils of increasing order of coefficient of viscosity. The diameter d of the impeller was $0\cdot542$ft, and the optimum efficiencies e and Reynolds' numbers r, corresponding to geometrically similar flows obtained from the test curves were :—

e	r	e	r	e	r	e	r
0·3	1,752	0·265	1,398	0·24	1,050	0·275	1,332
0·25	1,062	0·2	798	0·2	694	0·183	554
0·16	416	0·155	425	0·12	340	0·1	255
0·143	329	0·105	262	0·083	164	—	—

These figures are shown plotted in the accompanying diagram and a curve whose equation is

$$e=1/(1+1\cdot3+1800r^{-1}) \quad . \quad (10)$$

appears to fit the experimental points fairly well.

In this machine, the shock loss is 130 per cent of the delivery head. When the efficiency is 0·10, the surface friction is about six times the shock loss. When the efficiency is 0·3, however, the surface friction loss has fallen to a value of about three-quarters that of the shock loss.

Efficiency Step-up Formulæ for Turbines and Pumps

When the internal efficiency of a pump approaches unity, the losses due to shock and surface friction become small, and hence equation (2) becomes, to a close approximation :—

$$e=1-s-fr^a \quad . \quad . \quad . \quad (11)$$

a form which is exact for turbines.[5, 6, 7, 10]

The efficiency step-up formula (3) reduces to

$$(1-E)/(1-e)=(s+fR^a)/(s+fr^a) \quad . \quad (12)$$

an expression applicable to turbines as well as pumps when $e\rightarrow1\cdot0$.

It is interesting to note that one of the step-up formulae originally proposed for water turbines by R. Camerer[1] in 1909 took the form

$$(1-E)/(1-e)=(b+D^{-1/2})/(b+d^{-1/2}) \quad . \quad (13)$$

b denoting a constant which depended on the design of the turbine.

If, in addition to $e\rightarrow1\cdot0$, it is assumed that the shock losses are negligible, $s=0$, and equation (3) reduces to

$$(1-E)/(1-e)=(R/r)^a=(PH^{1/2}D\mu/\rho h^{1/2}dM) \quad . \quad . \quad . \quad (14)$$

When the same fluid is used in the model and full-scale prototype, then $\rho=P$ and $\mu=M$ and hence

$$(1-E)/(1-e)=(H^{1/2}D/h^{1/2}d)^a \quad . \quad (15)$$

In the case of smooth turbulent flow, $a=-1/5$, and hence

$$(1-E)/(1-e)=(d/D)^{1/5}(h/H)^{1/10} \quad . \quad (16)$$

a form which was proposed by the Author[6] in 1939, and by W. S. Pardoe[8] in 1941 for centrifugal (water) pumps and their models.

In 1926 L. F. Moody[4] proposed the formula

$$(1-E)/(1-e)=(d/D)^{1/4}(h/H)^{1/10}=(d/D)^{1/4} \text{ approx.} \quad . \quad . \quad (17)$$

for water turbine models and prototypes.

In 1942, L. F. Moody[9] proposed the simpler form,

$$(1-E)/(1-e)=d/D^{1/5} \quad . \quad . \quad (18)$$

for similar water turbines, and (tentatively) for similar centrifugal (water) pumps.

Conclusion

The main thesis of this note is that while an expression of the type (18) may be satisfactorily applied to extremely well-designed model and full-scale water turbines where the losses due to surface friction are large compared to those of the "shock" type, on account of the construction of the machines and the extent of their settings, the same expression need not necessarily be the best for pumps. "Shock" losses are bound to be higher in pumps than in turbines owing to the "diffusive" nature of the flow, and expressions such as (2) and (3) in which provision is made for a shock coefficient, become necessary.

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[10] G. G. McDonald, *The Australasian Engineer* (Sydney), Vol. 38 (1945), pages 56–57, 59.

Severn Bridge Scheme

THE Minister of Transport, the Right Hon. Alfred Barnes, M.P., has made an Order authorising the construction of the Severn bridge and its approach roads. The Order, which is made under the Trunk Roads Act, 1946, comes into force on August 1st. It is, in effect, the Minister's decision on the Inspector's report of the public inquiry held at Bristol last September into the scheme for the construction of a new road linking the main road from Gloucester to Bristol (A.38) on the east side of the Severn estuary with the main road from Gloucester to South Wales (A.48) on the west side.

The Severn bridge will be the largest suspension bridge in Europe and the third largest in the world. Only two bridges, both in the United States, have longer centre spans—Golden Gate, 4200ft; and George Washington, 3500ft. In addition to the centre span of 3300ft, the Severn bridge will have two side spans, each of about 1000ft. The vertical clearance for shipping will be 110ft above high water near the towers and about 120ft in the centre. The concrete anchorages to take the pull of the main cables will each be about 250ft long by about 130ft wide, and the concrete piers will be about 200ft long by 60ft wide. The steel towers, which will rest on these piers and support the main cables, will rise to a height of 480ft above high water. Each tower will consist of two legs about 30ft by 30ft braced by panels at roadway level, at the top and at about 70ft above the roadway. Accommodation for road traffic on the bridge will consist of two carriageways, each 24ft in width; two cycle tracks, each 9ft wide; and two footpaths, each 6ft wide.

A bridge will also be built over the Wye to carry the new road. It will have six spans of 150ft, two spans of 175ft and a central span of 200ft. The central span is for navigation purposes and provides a headway of 52ft above high-water mark.

The consulting engineers for these works are Messrs. Mott, Hay and Anderson, with whom are associated Messrs. Freeman, Fox and Partners, MM. Inst. C.E., both of Westminster. The consulting architect is Sir Percy Thomas, P.P.R.I.B.A.

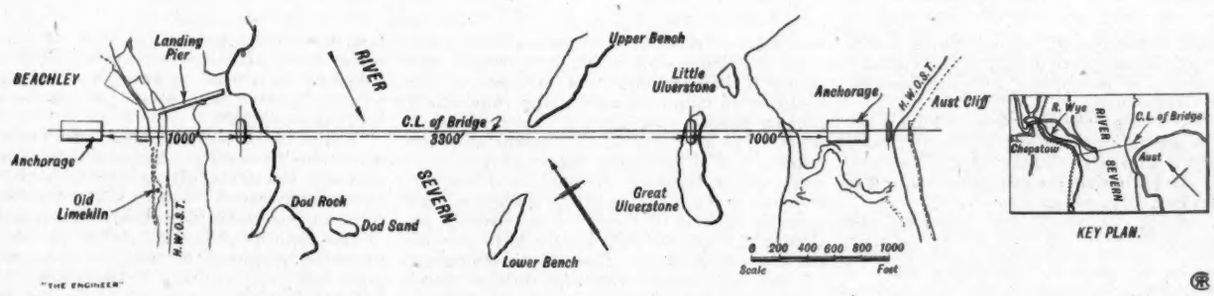
The new road, including the Severn and Wye bridges, will extend from its junction with the A.38 road north of Almondsbury to where it joins the A.48 road south of Haysgate, a distance of about 8 miles. The total cost of the scheme will be approximately £9,000,000.

The Minister of Transport inspected the proposed site in the autumn of 1945. Since that time preliminary work has been pushed forward. Soundings in the river and borings in the bed were carried out throughout the winter by men working from craft moored in the Severn estuary. As a result of the information obtained as to the depth and nature of the river bed and difficulties likely to be encountered in deep water construction, it has now been decided to build the eastern tower of the bridge on a rock outcrop known as Great Ulverstone instead of further into the river bed, as was originally proposed. The effect will be to increase the length of the large centre span of the bridge by 300ft to 3300ft, the longest in Europe. It should be noted that the architect's drawing, reproduced herewith, shows the original proposal with a 3000ft span. Other preparatory work for the building of the foundations of the main piers and anchorages is nearing completion, and it is intended to begin construction in the spring of next year. Tenders will be invited during the next few months for the building of the concrete piers on which the steel towers will rest, and for the massive concrete anchorages which will take the pull of the main cables of the bridge. Before work on the actual construction of the bridge can be started it will be necessary to build a breakwater on the western foreshore of the estuary for the protection of the workmen and to permit the existing ferry between Aust and Beachley to operate during the construction of the Beachley pier. Tenders for the breakwater will be invited in the near future and its construction will be started in the autumn.

ARCHITECT'S DRAWING OF SEVERN BRIDGE

Various measures for the protection of navigation on the Severn during construction of the bridge have been agreed after consultations with the Gloucester Harbour Trustees and other authorities concerned. Full details of these arrangements will, no doubt, be published in due course. Careful research into the aerodynamic properties of the Severn bridge are in course of being carried out on a model in a large and elaborate wind tunnel specially constructed for the purpose at the National Physical Laboratory.

The scheme will, of course, take several years to complete and the labour force engaged upon it is expected to build up to its peak of about 2500 men in 1951 and 1952.



SITE OF SEVERN BRIDGE

THE SUEZ CANAL.—At the annual general meeting of the Suez Canal Company, held recently in Paris, it was stated that the generally good condition of the canal had enabled dredging to be curtailed during the year 1946. Total dredgings were under 2,000,000 cubic metres and represented only two-thirds of the average yearly excavations for the last few years before the war. The present state of the canal bed, which was in every way as satisfactory as before the war, provided ships having the deepest authorised draught of 34ft with 1 clear metre of water under the keel. There were 5057 transits through the canal in 1946, representing a total net tonnage of 32,732,000.

Jet-Propelled Flying Boat Fighter

IN the accompanying engravings we show two views of the new Saunders-Roe "A1" jet-propelled flying boat fighter, which was demonstrated in the Solent on Wednesday last week, July 30th. It was designed by Mr. Henry Knowler, A.M.I.C.E., F.R.Ae.S., the chief designer of Saunders-Roe, Ltd., and the power units were designed by Dr. D. M. Smith, D.Sc., M.I.Mech.E., A.F.R.Ae.S., chief engineer of the Gas Turbine Department of the Metropolitan Vickers Electrical Company, Ltd., of Manchester. A convincing demonstration of the qualities of the new fighter was given by the chief test pilot of Saunders-Roe, Ltd., Mr. Geoffrey Tyson.

As will be seen from our illustrations, the machine is a single-seat jet-propelled flying boat, having a high wing arrangement with a single fin and rudder. The pilot is placed in a pressurised cabin forward of the wing, and is provided with an emergency projection device. The control arrangements are conventional in their design. The wing profile is of the high-speed type with single spar construction and chordwise stiffening. The hull follows the latest Saunders-Roe practice, with close-spaced frames and relatively light stringers. The wing floats are retractable in flight. The armament comprises four 20mm cannon, positioned in the nose of the hull, with a covering hinged for ease in re-arming. The military equipment is in accordance with full modern fighter requirements.

The two Metropolitan-Vickers "F2/4" jet turbines are totally enclosed within the hull, with the common air intake at the extreme bows. The jet outlets are positioned aft of the wing trailing edge, on each side.

The leading dimensions and particulars are as follows :—

Span	46ft
Aspect ratio	5 : 1
Length overall	50ft
Taper ratio	2 : 1
Height overall	17ft
Wing area	415 square feet
Hull length	50ft
Hull beam	6·83ft

The particulars of the two jet-propulsion units are as follows :—

Overall diameter	37·9in
Length	13ft 3in
Net dry weight	1750 lb

Thrust rating in lb at ground level static :

Take-off	Climb	Cruise
3500	3300	3000

Fuel consumption lb per hour per lb thrust :

Take-off	Climb	Cruise
1·05	1·05	1·00

Maximum speed	7700 r.p.m.
Idling speed	2600 r.p.m.

Thrust at idling speed less than 250 lb.

The aim of the company has been to provide a very high performance. The air intake at the bow of the boat is in the most efficient aerodynamic position, as it is designed to give the required ram effect which has so much influence on the efficiency of a jet unit. Extensive tank testing and last week's the demonstration showed that in normal operational conditions the bow is free from adverse spray effects.

Metropolitan-Vickers "F2/4" Jet-Propulsion Unit

The unit comprises a ten-stage axial-flow compressor, an annular combustion chamber, a single-stage turbine driving the compressor, an exhaust system and propelling nozzle, all arranged axially in line. The interesting features of this layout are the axial-flow compressor and the annular combustion chamber, with flow straight from compressor to turbine. Their use permits the development of large engine powers with a small frontal area.

The cycle of operation is as follows : Air enters the compressor through an intake guard and after the compression process it passes through a diffuser at the outlet from the compressor, where the flow is divided at entry to the combustion chamber. A proportion of the air flows through the backplate at the upstream end of the chamber into the zone of primary combustion and mixes with the atomised fuel sprayed upstream from the twenty jets arranged circumferentially around the chamber. The remainder passes through the axial annular spaces inside and outside the primary chamber and wall and enters the chamber at various stages of the combustion process through the holes provided in these walls. The products of combustion are thus reduced to a suitable temperature before entry to the turbine. The turbine drives the compressor and the residual energy in the gases is utilised to form a high velocity jet passing through the exhaust nozzle to provide the propulsive effort. The rotor is supported on two ball races, with the turbine wheel overhung. Both fixed and moving turbine blades are manufactured from "Nimonic 80" material and the turbine disc is machined from a molybdenum-vanadium steel forging. The compressor rotor, its extension piece and both fixed and moving blades are in R.R.56 light alloy. Blade attachments to the rotor are made by serrated roots in axial grooves and to the stator by dovetail section grooves with spaces between rows. The compressor cylinder, on which the unit auxiliaries are mounted, and the compressor inlet and outlet branches are of R.R. 50 light alloy.

The turbine bearing is enshrouded by the combustion chamber and efficient cooling is effected by a small supply of air tapped from the fourth stage of the compressor and delivered through the rotor to the bearing and its housing. Both bearings are spray-lubricated by oil entrained in low pressure air tapped from an intermediate stage of the compressor, the vapour from the bearings being vented to atmosphere. The turbine disc is cooled by air supplied from the compressor discharge. The total quantity of lubricating oil required by the unit is very small ; it is not recirculated and therefore the system does not require a cooler. The unit burns kerosene. The fuel control system has been designed to ensure automatic regulation of the rate of acceleration and the only control with which the pilot is concerned during flight is the engine throttle lever. Starting may be either by a small electric motor or by a small Plessey two-stroke petrol starter, specially developed for the purpose.

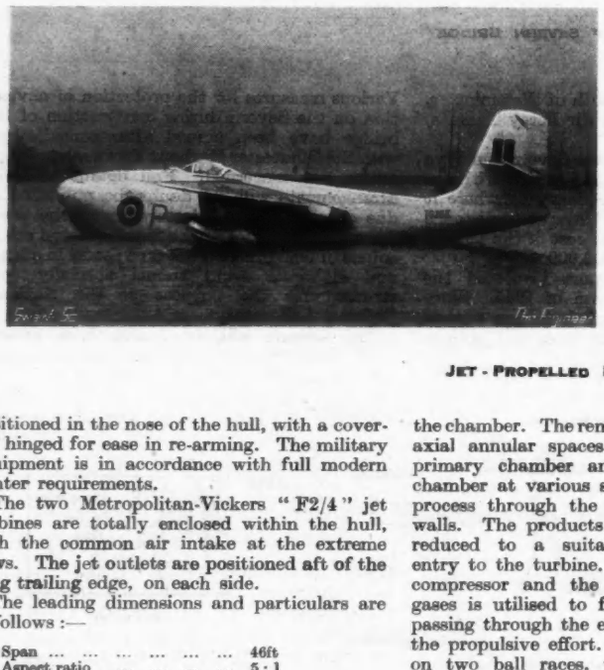
Applications of the Fighter Flying Boat

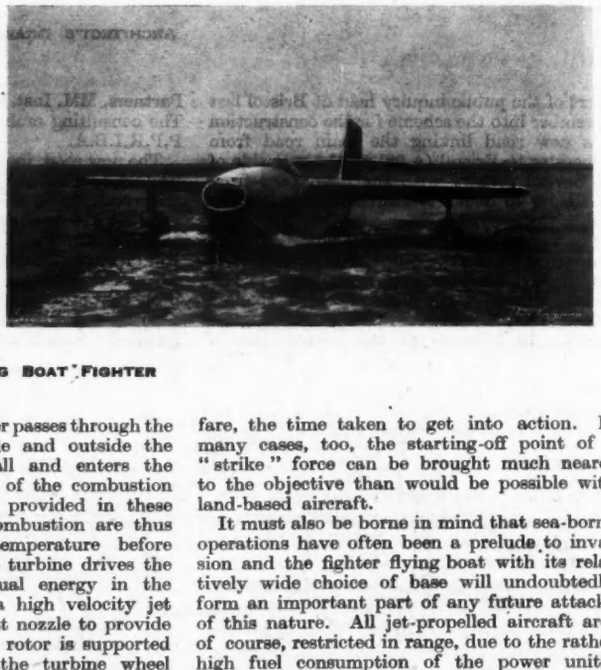
Events in the last war, especially in the Pacific zone, have confirmed that the land-based fighter has fulfilled its designed operational *rôle* quite successfully once the landing strip and base facilities have been built and means to defend them established. What is not generally realised is the very high cost in both men and material which has proved necessary. Unless carrier-based aircraft have been available, the establishment or capture of bases from which land-based aircraft could operate has been very difficult. Moreover, carriers and their accompanying surface vessels are particularly vulnerable to the enemy's sea and air forces.

The fighter flying boat on the other hand is independent of fixed bases, in the sense that any sheltered stretch of water will provide the runways required. This advantage renders unnecessary a mass of aerodrome constructional equipment, which is difficult to transport, and much reduces that vital factor in warfare, the time taken to get into action. In many cases, too, the starting-off point of a "strike" force can be brought much nearer to the objective than would be possible with land-based aircraft.

It must also be borne in mind that sea-borne operations have often been a prelude to invasion and the fighter flying boat with its relatively wide choice of base will undoubtedly form an important part of any future attacks of this nature. All jet-propelled aircraft are, of course, restricted in range, due to the rather high fuel consumption of the power units, but the flying boat type of fighter can overcome this difficulty by bringing its starting point closer to the scene of operations.

Another point is that enemy action not infrequently results in a forced landing on water—a far greater hazard to the landplane than to the flying boat. As a means of defence the fighter flying boat fulfils the same function as its land-based counterpart, climb and manœuvrability being comparable. In addition, it has the great advantage that its base is easily camouflaged and its runways cannot be made unusable by enemy attack.





JET-PROPELLED FLYING BOAT FIGHTER

The South Wales Ports.—Returns issued by the Great Western Railway regarding the South Wales ports of Cardiff, Swansea, Newport, Barry, Port Talbot and Penarth indicate that in the four weeks ended July 13th, the number of ships arriving was 1131, aggregating 600,636 tons net register. In the corresponding period of last year the arrivals were 1141, aggregating 632,245 tons net register.

Institute of Transport New Home

It is announced that the Council of the Institute of Transport has secured a new home for the Institute. It has purchased the lease of No. 80, Portland Place, London, W.1, a spacious house of great dignity, which is situated within five minutes' walk of Oxford Circus and a few minutes from the Regent's Park and Great Portland Street stations. This house will, it is stated, provide a worthy home for the Institute, with excellent amenities for the pursuit of its objects, including a common room, a library and a conference room. Last year, Sir Frederick Handley Page, then President of the Institute, made an appeal for contributions to an Institute Endowment Fund, with the object of securing a new home and applying more adequately the objects of the Institute. A target of £100,000 was set, and so far donations and promises have been received amounting to over £60,000. A letter has recently been sent to all members by the President, Mr. R. Stuart Pilcher, along with an architect's drawing of the new headquarters, appealing for increasing support for the Institute's Endowment Fund, which, it is pointed out, must be built up to £100,000 if the new premises are to be used to promote the work of the Institute to a maximum. Forms can be had from Mr. F. W. Crews, Secretary of the Institute, at 15, Savoy Street, Victoria Embankment, London, W.C.2. It is pointed out that contributors to the fund may spread their donations over seven years and thus enable the Institute to recover income tax at the standard rate on the annual payments.

British Radio Research

A report on "British Research in the Radio Field" was published recently by the authority of the Council of the Institution of Electrical Engineers. This report was prepared by a panel of experts set up by the Research Committee of the Institution to carry out a general review of the facilities in Great Britain for radio research and their co-ordination, and to consult with the Radio Section Committee upon these matters.

As a result of this review, the report draws certain conclusions under two main headings. First, there is the necessity for stimulating radio research in Great Britain, so as to ensure a steady flow of those new discoveries and ideas which are an essential raw material of a flourishing and progressive radio industry. Scarcely less important is the task of co-ordinating the research work undertaken by various organisations now operating in this country.

The most immediate method of tackling the first task is to stimulate the carrying-out by Universities of well directed programmes of research which, in addition to training graduates to pursue effective researches on their own account after leaving the University, stand a very good chance of leading to valuable discoveries in themselves. Another approach to the same end is the training, within the radio industry, of research workers chosen from its technical staffs as showing a special aptitude for this kind of work. After examining the present limitations of these facilities, the report makes a number of recommendations covering, *inter alia*, the provision of increased financial support, the discovery of new research leaders, long-term planning, the provision of buildings, and the staffing of laboratories.

Dealing with the second problem, the co-ordination of research work—the report makes the general recommendation that, because of the special character of basic research, no vigorous or repressive efforts at co-ordination are required in this field. It is suggested, therefore, that a reasonable measure of co-ordination in the researches undertaken in this country can be achieved by the present informal contacts between Directors of Research and their colleagues in the Universities and elsewhere. For the co-ordination of advanced development work undertaken in Government establishments and industry the report welcomes the setting up of Sir Stanley Angwin's committee on fundamental research in telecommunications.

Recognising the vital importance of making research results immediately available, the report recommends that a central agency should be set up to disseminate the detailed results of research work. This task, it is suggested, might come naturally under the ægis of the Department of Scientific and Industrial Research. An agency of the kind envisaged in the report would constitute a valuable intelligence service on the progress of British radio research, improving co-ordination and avoiding overlapping of effort.

The report emphasises that a necessary complement to research is the effective application of the results obtained from the research. It is suggested that although Great Britain bears favourable comparison with any other country in the quality of her basic radio research, there is room for improvement in applying the knowledge obtained from research to practical ends.

Copies of the report, price 1s., can be obtained from the Secretary, The Institution of Electrical Engineers.

New Standards for Steel Tubes and Tubulars

A new British Standard Specification, No. 1387 : 1947, has recently been issued, giving details of new standards for screwed and socketed steel tubes and tubulars used principally for gas, water and steam services. Under the new standards manufacturers are making available a wider range of thicknesses than has ever been available before. They have also introduced a new lightweight quality tube, which will afford a considerable saving of steel, a matter of great importance in these days of world-wide steel shortage.

In order to prevent confusion with tubes supplied to previous British Standards, two main changes have been made in the new Standard Specification. In the first place, the tubes are to be known as Class A, Class B and Class C, whereas previously tubes were known either as "gas," "water" or "steam" tubes under B.S. 789 : 1938 or as "lightweight" or "heavyweight" tubes under B.S. 789A (War Emergency) : 1940. Secondly, the colours indicating the thickness of these tubes have been changed. Under B.S. 789 "gas" quality tubes were self-colour, "water" quality tubes were painted blue and "steam" quality tubes were painted red. Similarly, under B.S. 789A "lightweight" tubes were self-colour and "heavyweight" tubes were painted red. The colours that have been adopted under B.S. 1387 are as follows:—Class A, brown; Class B, yellow; Class C, green.

It is understood, however, that manufacturers will have to depart from B.S. 1387 as regards the painting of ungalvanised tubes. This is the consequence of the fact that raw materials for paint, and in particular linseed oil, which is an edible oil, are in very short supply. Instead, therefore, of painting ungalvanised tubes in the above colours throughout their length, the manufacturers will supply the tubes coated with a special anti-corrosive varnish and with the appropriate distinguishing colour band near each end of each tube. They will also supply galvanised tubes in future with the appropriate distinguishing colour band near each end of each tube, instead of only at one end, as in the past. In its protective properties the varnish is claimed to be equal in every way to paint, whilst it will also be an entirely suitable base for the application of further protective or decorative coatings.

Manufacturers are issuing brochures (the receipt of which will be acknowledged in our "Catalogues" column) giving full details of these new standards, and it is interesting to note that, whereas B.S. 1387 makes no mention of the processes for which the different qualities of tubes should be used, the manufacturers make recommendations in their brochures as to the working pressures in terms of gas, water, steam and air services for which the various qualities can be used. For instance, screwed and socketed Class A tubes are recommended for working water pressures ranging from 80 lb to 150 lb per square inch, according to size, whilst screwed and socketed Class B tubes are recommended for air or saturated steam working pressures from 60 lb to 150 lb per square inch, according to size.

One further point to which attention should perhaps be drawn is that screwed and socketed Class A tubes may be supplied with somewhat shorter threads than Classes B and C tubes. B.S. 1387 provides that the useful length of thread on Class A tubes may be 80 per cent of the useful length of thread shown in B.S. 21 : 1938, Table 3, column 7. Standard pipe fitters' dies, however, can be used for threading Class A tubes and standard sockets and fittings can also be used in conjunction with them.

Tubulars also are covered by the new specification and manufacturers' brochures give details of the classes of tubes from which the various types of tubulars will be produced. The above comments refer particularly to tubes used for pressure purposes. The same tubes are, of course, available, and are finding an ever-increasing use for a wide variety of structural purposes and general engineering work.

Building Development in America

A notable feature in recent developments in the building industry in the United States is a widespread movement for the preparation and adoption of a standard municipal building code. Many existing codes are obsolete and obstructive, and few are competent to deal with modern progress in building materials and architectural design. Several States have adopted or are preparing State building codes, and a number of cities are planning revision of existing codes, especially to permit the introduction of new materials and methods, as in the case of new housing projects. But with so many individual codes, the regulations are diverse, and what may be permissible in one city may be prohibited in another, although conditions may be similar. To meet this condition, a technical and industrial association has been organised to prepare a standard building code suitable for universal use. Serious fires have brought to light a frequent neglect of safety regulations in the design and alteration of buildings. Thus, there is need for periodical inspection to prevent such accidents as floor collapse of structures in which changed occupancy has resulted in overloading. In alterations, also, liberties may be taken with the structural design, as in the removal of bracing found at points where new door or window openings are desired. Closely allied with this improvement of building codes is the preparation of a standard plumbing code for use by municipal and State authorities. A study of some 1600 codes shows wide variations, due largely to old customs and practices and lack of knowledge of new materials and methods. A comparatively new but expanding development is the air-conditioning of buildings so that occupants of dwellings, hotels, rooms, &c., may regulate their individual temperature and moisture conditions. In central heating there is increasing use of radiant heating from steam or hot-water pipes embedded in the walls, floor or ceiling.

Heat Pump Developments.—The London Committee of the Engineering Industries Association has decided unanimously to consider the commercial possibilities of the heat pump which has for the past two years been abstracting heat from the River Wensum at Norwich. Full details of the pump and its estimated cost are to be circulated to the members of the Association throughout Great Britain. A description of the Norwich heat pump, it may be recalled, was published in The Engineer of August 31, 1945.

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

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For Subscription Rates, see page 2 of Advertisements.

THE PROMISED MACHINE TOOL EXHIBITION

THE recent announcement by the Machine Tool Makers' Association that an exhibition of machine tools will be held in London next year will be welcomed by engineers. For whilst this class of machine is indisputably the basis of all forms of engineering development and production, engineers have not had the opportunity to see an exhibition of British machine tools since that remarkably fine one held at Olympia as long ago as 1934. Though some machine tool manufacturers contemplating overflowing order books may wonder how time is to be found to produce tools for exhibit and how staff to demonstrate the tools is to be spared from productive work, the majority will, we believe, welcome the opportunity to show the world at large that, subject to certain exceptions in highly specialised plant which it is not economic to produce in this country, they can design and build machines surpassed by none. Since the 1934 exhibition there has been little opportunity to show engineers at large the many developments which have taken place in the machine tools designed and built in this country. Exhibitions of this type of plant have, of course, been held abroad, but, although a few British firms have been represented, the true scope of the industry in this country is less well appreciated, not only by foreigners, but also by many of our own engineers, than it should be.

In the absence of British machine tool exhibitions the technical press has done much to keep prospective users informed about machine tool developments, but restrictions imposed by paper shortages in recent years have made this work increasingly difficult. Another difficulty has been the disinclination of certain manufacturers to disclose information on their new machines owing to the fact that they are unable to keep production in step with their order books. No user or prospective purchaser can hope to see and inspect all the makes of a machine he requires in order to compare their respective qualities. Often he has only time to see one or two designs and has to make his choice from a limited selection, and may later, often after purchase, find that a machine more suitable for his purposes is, in fact, made. Many of the developments which have taken place in machine tool design in recent years have occurred as a direct consequence of the advent of new or improved materials; and not infrequently the design of a machine has been primarily based upon the capabilities of a particular tool. Carbide tipped and negative rake tools and other improved tool materials have each played their part in making more rigid machines with higher cutting speeds and feeds essential in order to take full advantage of their machining properties. Hydraulic operation of many machines is now an accepted fact causing little comment, and electronic means of control might well now be considered to have passed the initial stages of development for application to certain machine tools. The limits of accuracy to which machine tools are now automatically capable of working without any undue effort of skill on the part of the operator are impressive, and the increasing use of optical setting methods on precision finishing machines often makes "spot on" working possible with semi-skilled labour. Although basically the modern machine tools have altered relatively little, they have reached a stage of development where it has become obvious that many of the old machines still retained in works because they can "do a good job" must be replaced if the users hope to produce economically and efficiently. It is only by the evidence at exhibitions such as that which will be seen next year that less progressive users can be convinced of the unwisdom of retaining inefficient out-of-date plant.

It can be said with little fear of contradiction that practically every engineer, whatever his ultimate goal professionally, had his first introduction to practical mechanics through operating a machine tool. It would, too, be difficult indeed to find any engineer who, even when the passing years have surrounded him wth executive responsibilities has ever lost his earlier interest in machining operations, and the tools that perform them. The love of machine tools is inherent in all engineers, and we fear that it is not particularly to the credit of the profession as a whole that this branch of industry was so badly neglected in this country for several years prior to the war. The fact that at the outbreak of the late war the average age of machine tools in use in this country was some twenty years was surely a reflection on industry hard to excuse and as difficult to explain, in view of the relatively low cost of many of the new machines which could have replaced the older inefficient ones. By revealing the full scope of British machine tool design and making possible the comparison on the spot of one tool with another, by bringing prospective users, foreign as well as British, into contact with firms with whose products they may not be wholly familiar, and by stimulating the interest of executives as well as that of machine shop specialists, the holding of the exhibition next year will serve a really useful and important purpose quite apart from the "business," oversea and inland, that may be done on individual stands.

WATER SUPPLIES

PROBABLY no other utility is more taken for granted by the inhabitants of towns in this country than is that of water supply. It is true that the supply to rural districts is in many parts of the country inadequate and unsatisfactory. The recent Rural Water Supplies and Sewerage Act is designed to alleviate that condition, though it still remains to be seen how effective it will prove. But within ordinary living memory the supply of water to the majority of our towns has seldom been seriously interrupted or unsatisfactory. Only in long periods of drought has there been any tendency even to call upon consumers for economy or to ban the use of hoses, &c., for the watering of lawns and gardens, lest storage reservoirs be too much drawn upon for safety. Thus, though not unexpected amongst water engineers, well aware of the real situation, the announcement by the British Waterworks Association that we print on another page of this issue and more particularly the remark that "a situation is thus developing in which the possibility of a partial failure or curtailment of water supplies can no longer be ignored" may give rise to some degree of shock to the public.

Of course, water supply concerns in these post-war days have not been immune from those shortages that are affecting every other business in the country. Even the running of existing plant has been rendered the more difficult by shortages and irregularities in the supply of chemicals, &c., while repairs to plant and the delivery of replacements have been subject to such delays that, as Mr. McMillan pointed out in his recent Presidential Address to the Institution of Water Engineers, "the normal duplication of plant is no longer sufficient for safety." As the announcement indicates, those difficulties have, up to date, been overcome by drawing upon stocks of materials built up before and during the war to meet emergencies that might arise from enemy action. Those stocks are now running low and cannot much longer be depended upon. Furthermore, water supply concerns are now being called upon, not only to make available water in quantities similar to those required before the war, but for quantities enhanced far beyond pre-war expectations. The Metropolitan Water Board, for instance, is experiencing a demand at the rate of 51·83 gallons per head per day, as compared with a figure of 43·84 gallons per head per day

before the war and a figure of 45·26 gallons per head per day which might reasonably have been expected at the present time from the trend of the pre-war rate of increase. No doubt other water supply concerns have experienced a similar unexpected jump in the demand. It is an increase so remarkably heavy that it would be wholly unjust to lay blame upon the supply concerns because provision had not been made earlier to meet it. Such demands have now to be met despite the more or less complete cessation of normal development work upon water resources and purification works during the war, works planned to meet, moreover, only the rate of expansion in demand that seemed wholly reasonable at that time. Nor is it simple now to put in hand new works that could be expected rapidly to ameliorate the position. Labour itself for doing the necessary work is in short supply and there is difficulty, too, in finding a sufficient number of qualified engineers to operate existing plant. At least as serious a shortage is that of cement, without which it is impossible to start the construction of many new works. Moreover, more particularly on the distribution side, the supply of pipes is scarcely adequate, whilst lead is very seriously short. Further proposed building developments around urban districts are so large in some areas that wholesale re-design of distribution systems and relaying of trunk mains is called for. Such conditions lead inevitably to the warning in the announcement by the British Waterworks Association, "nor can it any longer be assumed that the supply of water to new housing projects will necessarily keep pace with development."

Very soon after the termination of the war the public was made aware of the shortage of electric generating plant by more and more frequent "cuts." Gas pressures, too, in the depths of winter, when heat was most desired, had to be lowered, revealing the difficulty the gas companies were experiencing in meeting an enhanced post-war demand. Up to date, however, except for localised and temporary shortages arising out of special conditions, such as the flooding last winter of pumping stations, water has not been in short supply. The announcement published last week indicates that a continuance of that relative immunity can no longer be counted upon. It is, of course, particularly intended to inform the general public about the real position and to act as a warning that economy in the use of water is really necessary. But if, as foreshadowed, it does become necessary by some means to restrict supplies of water in any area, it is to be hoped that special arrangements will be made to avoid the interruption of bulk supplies to industrial establishments. Industry has difficulties enough to contend with without adding shortage of water to existing shortages of fuel and power, raw materials and transport.

Literature

Report on German Blast-Furnace Practice and Plant. British Iron and Steel Federation and British Iron and Steel Research Association. 1946. 10s. 6d.

MANY teams of scientific and technical experts have visited Germany since 1945 under the auspices of the Intelligence Objectives Sub-Committees to investigate the conditions of German industry, with special reference to developments which took place during the war. Their findings are contained in the very large number of C.I.O.S. and B.I.O.S. reports which continue to be issued by H.M. Stationery Office. Although the final reports represent a notable condensation of the enormous mass of detail which was at the disposal of the investigators, they vary in the degree to which attention is focused upon the salient features. At the best a considerable amount of reading is necessary to get a picture of even a limited field of activity, and there is an urgent requirement for concise statements of the trends of development, outstanding advances and achievements in particular branches of German industry. This need has been admirably met in their own field by the team of experts who investigated the developments of German blast-furnace practice and design.

At the request of Sir John Duncanson, these investigators have prepared a joint report outlining the developments which will, in their opinion, be of most interest to members of the industry in this country. They have compressed into 52 pages of text, supplemented by a short tabular appendix and a comprehensive series of dimensioned drawings, a review of all the important features of German blast-furnace practice and plant, and, further than that, have provided in a 2-page introduction pointers to all the outstanding features discussed in the text. Chief among these were new sources of supply of iron ores, the methods by which increased use was made of indigenous ores, their preparation for the furnace and the extended use of sintering, improvements in blowing and gas-cleaning equipment and experiments on the use of oxygenated blast. There is also a 7-page appendix on experimental work which had been carried out at the August Thyssen Hütte, Hamborn, with the object of enlarging the oxidation zone and so increasing the amount of coke burnt and of iron produced in a given furnace.

In blast-furnace design there was little to be learned. The investigators were impressed by the manpower required to operate the pre-war German plants and by the absence of any attempt in the designing of lay-outs to save labour. Twelve new blast-furnaces were constructed during the war at the Reichswerke, Watenstedt, and two in the Ruhr. All these furnaces were of the British and American type, with inclined hoist and skip charging. The principal feature of interest in furnace construction was the marked extension of the use of carbon linings for the hearth and bosh. The use of this material has proved very successful and the furnaces so built have given record lives and tonnages, with freedom from operating troubles.

The investigators are to be congratulated on this report, and the Federation and Research Association in publishing it have rendered a valuable service to the industry. There is a need for such critical surveys of the mass of material that has accumulated. This report might well be taken by other industrial organisations as a model of the type of publication required to enable them to extract the greatest practical value from the available information. The team of investigators responsible for the report were :—Dr. T. P. Colclough, Messrs. H. G. D. Debenham, G. D. Elliot, E. C. Evans, R. Frost, R. A. Hacking, J. W. Houghton, J. M. Ridgion, I. S. Scott-Maxwell, and J. F. Stainier.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SCIENCE, LIBERTY AND PEACE

SIR,—I should welcome an opportunity of replying to the letters of Messrs. Taylor and Watson, published in your issues of July 25th and August 1st.

Mr. Taylor attempts to reduce the previously stated opinions on this subject to two erroneous schools of thought.

Oddly enough, in seeking to disprove them he has only succeeded in proving them, for after an assertion that technique has not influenced human behaviour or welfare either way, he goes on to assert that they quite frequently do influence one another.

The idea that "technique and humanity are like beauty and utility, distinct aspects of a problem" is quite meaningless unless the nature of the problem is also stated.

The analogy is false, however, because it attempts to over simplify the nature of the relationship existing between technique and humanity. Technique has shaped and has now become for better or for worse an intrinsic part of our environment.

The problem, then, is not "technique and humanity," but "man and his environment."

If, on the other hand, Mr. Taylor is inferring that man is primarily spiritual and thus above his environment, my reply would be that very few men are primarily spiritual, but the majority of us in whom the spirit is weak will only be induced to tolerate that precious minority by a subtle balancing of environmental factors and acquired psychological restraints.

The point at issue for the less saintly is hardly whether or not mechanisation *per se* is bound to make men more or less "moral," "good" or "bad," but whether or not the specific framework of society, which centralised industrial activity has willy-nilly thrust upon us, makes possible the emergence of what, for lack of a better term, we call the whole man—that is, a man whose activities are balanced, whose daily work and social functions call for that integration of skill, intelligence and æsthetic satisfaction, &c., which psychology and common experience shows to result in a sense of well-being and responsibility.

Inasmuch, then, as modern society by its nature demands increasing specialisation, it is tending to produce not the whole man, but a disintegrated or nihilistic man.

In all animals the interplay between the psycho-physical organism and environment is so intrinsically bound that it is clearly impossible even to consider one without reference to the other.

Mr. Taylor inadvertently refutes this. By doing so he refutes incidentally that education can teach, that we can have learned enough sense to avoid walking under a bus, or that widespread traditions of good social conduct can deter most men from murdering and robbing their neighbours.

Many of the traditional restraints and individual liberties so long regarded as axiomatic to civilised society have clearly and increasingly become incumbent to the process of adaptation called for by our rapidly changing environment. Consequently they are being discarded, however reluctantly, in the interests of expediency. Unfortunately the whole trend of industrial

activity in its present form makes their return exceedingly improbable. Is it not, then, imperative that we should examine very closely whither we are going?

Mr. Watson, in his letter, makes a pretty successful job of begging the question. He asserts that due to a misapplication of political slogans the struggle to-day is for less work and more food from the food-producing areas.

I made perfectly clear in my letter that in my opinion modern man tended to be irresponsible and I further attempted to outline in the most general terms the factors inducing this state of mind.

Whilst I wholeheartedly support his idea that an attempt at national self-sufficiency is imperative, I would ask him on what grounds he considers mass production methods applied to agriculture would not further extend the alleged struggle for less work.

It is surely not necessary to implore, say, a self-supporting Swiss mountain community to "Work or Want," or to find it necessary to employ every propaganda device known to induce them to bring in the harvest.

That it is necessary to implore a modern civilised society to do a precisely similar thing is not due to a misapplication of political slogans, but due to a collective divorce from the essential roots of community life. I reassert, therefore, that this breach has widened in direct proportion to the demand for greater and, hence, more specialised production.

Further, in attempting to lay the blame for our present troubles upon "misapplied political slogans," Mr. Watson ignores the fact that not only in England but in the U.S.A. and other industrialised states, pre-war agriculture was hardly able to support itself and only then with the aid of state subsidies.

Farming by its very nature has lent itself only to a very limited extent to the centralising process which has telescoped other industries and activities.

Agriculture has, in consequence, suffered because capital has followed the centralised industrial and specialised produce enterprises rather than the unprofitable small farmer.

The case for a reversal of present industrial and social trends from centralisation to de-centralisation is formidable and far-reaching.

Finally, from "democratic ideals" I expect a right for all to challenge the beliefs of those who have it within their power to fashion our earthly existence.

G. A. FELTON.

London, W.11, August 8th.

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Aircraft Engines, Vol. II. Second edition. By A. W. Judge. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 36s.

Mechanical Vibrations. Third edition. By J. P. Den Hartog. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 30s.

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American Railway Developments

By E. E. RUSSELL TRATMAN

No. I

THE permanent-way departments of American railways are facing just now crucial problems in railway operation, owing to the increase in wheel loads, train loads, speeds and traffic. Normally, these increases would be countered by improvements in track construction and maintenance, but the situation is complicated by the enforced neglect of work during the war period, and the shortages of men and materials in the present early stage of the post-war period. Under these circumstances, active consideration of permanent way in relation to traffic conditions is being given by railway engineers. This activity is illustrated by the following abstract of a group of reports relating to track which were presented at the 1947 annual convention of the American Railway Engineering Association, held at Chicago, U.S.A.

ROADBED OR FORMATION

Railways operate under the fundamental disadvantage that the foundations of their lines consist of a vast and varied assortment of soils and soil combinations, all subject more or less to the disturbing influences of wind and weather, causing settlement, softening and erosion or displacement. Thus the bearing capacity or load capacity of the roadbed or formation upon which the lines are laid is of a varied and changeable character, while its quality decreases with increasing loads and speeds and traffic volume.

On a large proportion of the mileage, therefore, there is no distinct plane of contact between ballast and roadbed, the ballast being driven down into the soil and the soil working up into the ballast. All this results in need for steady increase of maintenance work on the track to keep it in proper condition for the traffic which it carries. This, in turn, results in increased cost of the work of maintenance. These practical and economic difficulties apply to railways in general. To overcome them, there has been developed in recent years on a number of American railways a comprehensive experimental study of methods for the stabilisation of the soils upon which the ballast is laid. Such treatment has a marked effect upon the physical properties of the soils, as evidenced by substantial savings in the cost of maintenance.

The principal method of stabilising is the injection of cement grout or slurry, of various mixtures and sometimes with an admixture of asphalt or other materials. These experiments have demonstrated that there is available a relatively inexpensive method of improving the stability and load-bearing capacity of the soil, and that it is applicable without interference with train operation. That the soil of the road bed—or formation—is over-stressed by traffic loads is often indicated by excessive expense for maintenance of satisfactory alignment and grade. There probably is a proper balance between the rigidity of the rails and ties—or sleepers—and the stability of the ballast, which together may keep the soil pressure within permissible limits.

Pressure grouting has been carried on by several railways, and the combination of effective performance and reasonable cost has proved the value of this soil stabilisation. Two methods are in general use: pneumatic pressure and hydraulic pressure. The former has been used almost exclusively on comparatively short sections, with small crews, but also in cases where the ballast itself is to be grouted. The hydraulic method has been used more generally on longer stretches of work and on embankments where the absorption of grout is high. Common portland cement is used, with air-entraining cement in some cases. Mixtures range from 1 to 1 or 1 to 4 for the pneumatic method, and 1 to 3 or 1 to 30 for the hydraulic method.

In the earlier work, pressures as high as 70 lb to 100 lb were used, but at present 40 lb is considered more effective, as the high pressures tend to cause segregation, with consequent plugging of the base lines. Injection points are usually 1¼in iron pipes, 6ft to 10ft long, with perforated ends and attached to hose from the air compressor or hydraulic pump. They are driven usually at an angle of 30 deg. with the vertical. Where the ground is too hard for the injection points, holes are formed by solid bars 1¼in or 1½in in diameter, driven by air hammers. These are known as hard-points.

For such special work as grouting deep pockets of ballast, wet cuttings and sliding embankments the content of cement is often increased with either method of injection. The use of asphalt emulsion has increased, due to its value in lubricating the flow of grout and in keeping the solids in suspension. Its proportions range from 0·1 to 0·2 gallon per cubic foot of sand. The sands used for grout vary considerably in grain size and shape of particles. Fly-ash, produced from the combustion of pulverised coal in steam plants, has been used as a filler for the sand, as it has some plasticity and may reduce the amount of cement, besides increasing the workability of the grout.

From records of various jobs it appears that for general soil stabilisation of the roadbed, a relatively lean grout is as effective as a rich grout, but where it is desired to obtain a direct increase in the supporting or bearing capacity by penetrating the ballast, the richer mixes are more effective.

An example of this work, shown in Fig. 1, is a stretch of single-track main line of the Chicago, Burlington and Quincy Railroad in Nebraska. Injections were made at intervals, but staggered in position so that there was not a full set of holes at any cross section. Holes in the slopes and shoulders were grouted first, and those nearest the line were left for the next day. The shaded area represents a trench cut to show the penetration of the grout. Grout was composed of one part cement and six parts sand to 32 gallons of water, making a relatively thin grout for use in clay soil. For this work an extra gang was organised, living in camp cars. It included the machine operator and his helper, three men handling materials, one man on water supply, three men on each of the two hose or grouting lines, and two men driving the injection

points; also the foreman and equipment maintainer. This gang would average the placing of 350 to 650 cubic feet of grout daily, or 50 to 100 lineal feet of track. But the performance varies with the conditions of every job.

Another example, on the New York Central Railroad, in Indiana, is shown in Fig. 2, indicating the arrangement of grout holes with the amount of grout injected at each hole. The figures show the absorption and the depth of penetration. Grout was composed of 1 cubic foot of cement, 1 cubic foot of sand, and 2 cubic feet of pulverised limestone to 12 gallons of water. A crew of seven men with a foreman averaged 50ft to 100ft of one line per day. A report states that study of the economics of pressure grouting on a number of railways indicates resultant savings in track maintenance. Such savings often absorb the costs of stabilisation in two or three years.

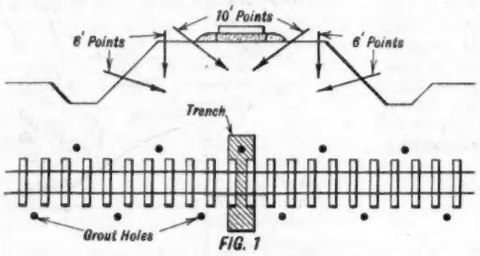


FIG. 1

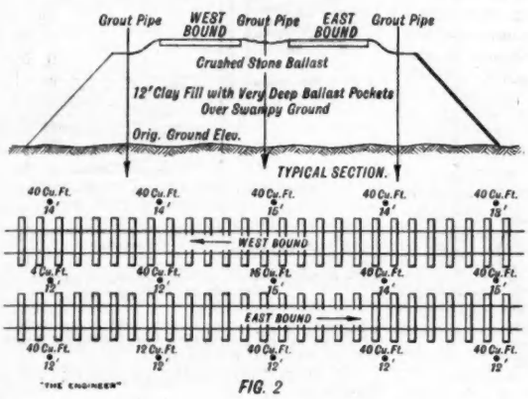


FIG. 2

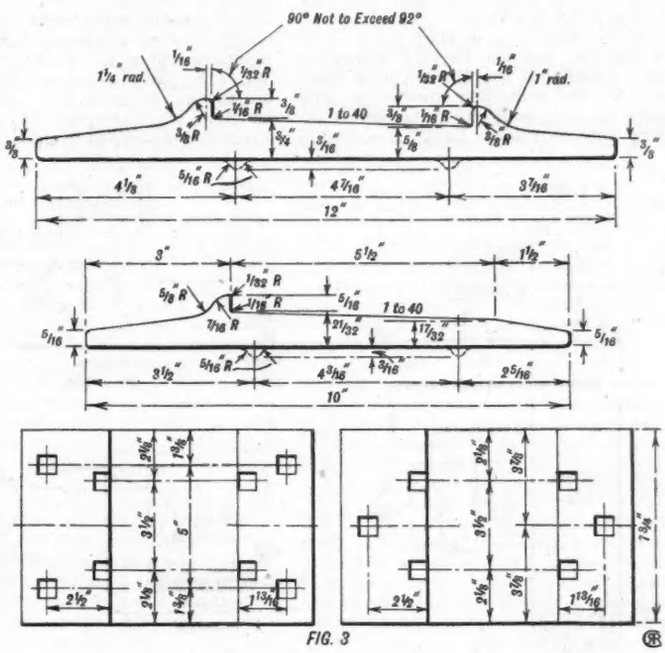


FIG. 3

The grouting may be done by railway forces or by contract.

Ballast

Changes and developments of recent years are thought to indicate the necessity of a study of ballast materials and ballasting practice under present conditions of railway operation. For instance, increased train speeds require higher standards of maintenance, and greater axle loads may call for increased depth of ballast. The ballast should be of such material and quality as to require only a minimum of section labour on maintenance. Increased cost of labour requires further mechanisation of the work of section gangs and extra gangs, while still additional mechanisation is required by the reduction in supply of labour and the consequent desirability of reducing or eliminating extra gangs. Increased cost of materials and labour may also justify the use of better but more expensive ballast. On the other hand, stabilisation of the roadbed, as above described, not only reduces the maintenance labour for spotting and aligning the track, but may also eliminate the use of better or special ballast where the roadbed is soft.

Increasing use of pneumatic and electric tampers or packers, especially by section or length gangs in making light lifts for surfacing, points to the need for study of the effect of such power equipment in the crushing or disintegration of the ballast. This study would include also the desirability of using the smaller sizes of ballast, as often urged by the section foremen or gangers in order to expedite the work and to reduce the disintegration of ballast when being tamped or packed. There is need also for some economical method of cleaning the shoulder ballast at regular intervals, so as to provide free drainage from under the ties, or sleepers, and in the cribs or spaces between the ties, and thus prevent churning of the ballast in wet spots.

Four ballast studies are now in progress. First, depth of ballast required for proper distribution of the traffic load. Second, effects of tamping methods on the stability and breakage of the ballast. Third, influence of size of ballast on drainage, fouling and stability; this will include maximum sizes from 3in down to 1in. Fourth, effects of periodical mechanical cleaning of shoulder ballast.

Ties and Tie-Plates

A report notes that an increase in cost of ties, or sleepers, which began in 1941, has continued. A decrease in the number of ties applied annually during the same period is said to reflect a shortage of manpower in maintenance rather than either a shortage of ties or reduced requirements by the railways. From field inspections covering some 640,000 ties, it is evident that railway purchasers are holding up the quality of their inspections and handling in storage. The manufacture or production of the ties, however, was not always up to pre-war standards, and an unusually large proportion were of smaller sizes than before the war. These objectionable features can be corrected if the railways insist upon the quality, sizes and workmanship called for by the Railway Association's standard specifications.

An interesting section of the report reviews the experiments with substitutes for wood ties. No new substitutes have appeared since 1940, and most of those of the earlier lots have been removed from the line. Their performance was generally unsatisfactory, and their service life did not justify their higher cost. Since creosoted wood ties have come into common use, it is a general opinion that any satisfactory substitute would cost more per tie per year. However, the current high prices of wood ties have led to renewed study of the matter, and on the basis of the earlier experiments and the development of new materials, it is suggested that satisfactory substitute ties may yet be produced.

Omitting all defunct designs, specific examples of remaining substitute ties are listed. Of 26,962 brown concrete ties installed 1925–1930, on the Pennsylvania Railroad, 8028 remain. Of 1,329,386 Carnegie steel I beam or joist ties laid on different railways in 1904–1923, only 455 remain, and these are in yards with light traffic. Of 983 Snyder composite (steel and concrete) ties installed in 1906 in a yard of the Pennsylvania Railroad, 966 remain. Of 149,317 Dalton steel ties, made from scrap rail and joint bars and laid in 1927–1938 on the Delaware and Hudson Railroad, 147,393 were in service in 1945.

Steel tie plates or base plates, placed between the rails and wood ties have constituted a confused and uneconomical situation, since various railways have had their own sets of designs. In a movement started a few years ago to reduce this confusion, there were noted some 350 different sections and 610 different arrangements of the holes punched for the spikes. As a result of conferences between the American Railway Engineering Association and the American Iron and Steel Institute, a series of fifteen standard designs was presented as meeting practically all requirements, with ten more to meet special conditions. They include plates with single and double shoulders, as shown by the typical designs in Fig. 3. All the designs have separate holes for spikes holding the rails and for spikes attaching the plates to the ties. These holes may be round for screw spikes or square for ordinary spikes. The plates are from 7½in by 10in to 7⅞in by 15½in in size.

The present study is expected to lead to specific basic designs, but it is not considered practicable or desirable to establish fixed arrangements or dimensions for the punching of the spike holes. It appears that screw spikes are the most effective in minimising movements of the plates, which movements are a cause of mechanical wear of the ties. The report ranks elastic spikes third and common spikes as second and third in this respect.

(To be continued)

Automatic Control in the Chemical Industry*

Introduction

The main body of chemical plant was designed at a time when automatic controls were comparatively trivial. To-day it is probably true to say that, on old and new plant, each point is assessed for its suitability for automatic control, and such controls are installed wherever a well-tried design is available.

One of the difficulties in older plants is to find a suitable position for the measuring element. Another is the absence of suitable locations for the controllers themselves, and frequently it is not possible to group them without using long instrument lines. A scattered distribution of a number of controllers is inconvenient and time wasting for both process and maintenance. The controlled devices, *e.g.*, valves, cannot always be placed in the best positions or arranged to operate in optimum conditions for efficiency, because of the lay-out of pipe lines, vessels, &c.

Plants are now designed to eliminate these faults as far as possible, and among those erected within the last seven or eight years are plants whose processes are so complex or demand such close and accurate correlation of variables that they could not be run without difficulty by manual control alone and are almost completely automatic. In spite of this, no study has yet been made of the improved results which would be obtained by designing plant to take full advantage of automatic controls. The designer cannot yet make complete use of automatic control to reduce the size and hence the cost of a plant, because the basic information is not available. He does not know how much output and quality could be improved; all he can do at the present time is to ensure that the controls installed are given the best working conditions, as indicated by present practice. The design of plants continues therefore to be conservative, although this is the result of lack of knowledge in other spheres of chemical engineering as well as in automatic control.

[Here the paper goes on to indicate some of the difficulties experienced with the primary measuring element, and then describes the various mechanisms used for automatic control in the chemical industry, with particular reference to pneumatic and hydraulic control systems.]

The Controlled Process

Whilst the controlled process is equally an important a link in the control loop as the measuring element, controller or controlled value, it is true to say that it is the link about which least is known. Mathematically, the behaviour of the other components of the loop can be predicted with some certainty, yet it is only in the simplest of processes that a fairly accurate estimate of the likely control conditions can be made when the plant is being designed. This inevitably leads both to over-designing and to a "cut and try" technique. When the plant is designed the controls which are thought likely to be required are chosen, and then when the plant is in production the controls are modified in the light of experience. The modifications referred to are not the adjustment of proportional band, floating rate, &c., of the controllers. These are details which can be adjusted during the initial stages, although the ideal control system would be capable of starting up the plant initially. The modifications required are more fundamental and embrace such things as reducing process lags by repositioning the measuring element, altering sampling methods, improving mixing, &c., and frequently go as far as requiring a complete redesign of control equipment based on the actual running conditions obtained.

Thus at the present time, whilst the major difficulties are looked for and avoided during the design stage, a great deal remains to be done before the empirical approach to the problem can be replaced by a more fundamental one which would allow the requisites of the control system to be accurately predicted in the design stage. The reason for this is, of course, the large number of, at present unpredictable variables which affect the final result.

The best that can be done is to consider instrumentation at a very early stage in the preparation of the initial flow sheet and plant design. Frequently it is found that by a rearrangement of plant, the installation of a different design of condenser, heat interchanger, &c., control could be very much simplified and a large amount of process lag eliminated, whilst in no way upsetting the process conditions specified.

Future Developments

Process Analysis.—Process analysis obviously offers a very wide field. A comprehensive mathematical treatment already exists for dealing with the problems which occur in electrical networks and feedback amplifiers, and it seems likely that these methods might well be applied to the analysis of chemical processes. If the technique were successful—and in view of the success gained during the war with servo mechanisms it appears likely that it would be—then a powerful tool would be placed in the hands of the chemical plant designer.

Success would enable the practice of automatic control of chemical processes to be pushed still further. Thus it would be possible to work out a general economic treatment of process control to find :—

(*a*) How far the cost of building a plant can be reduced by designing the plant to make full use of automatic control.

(*b*) How much running costs would be thereby decreased.

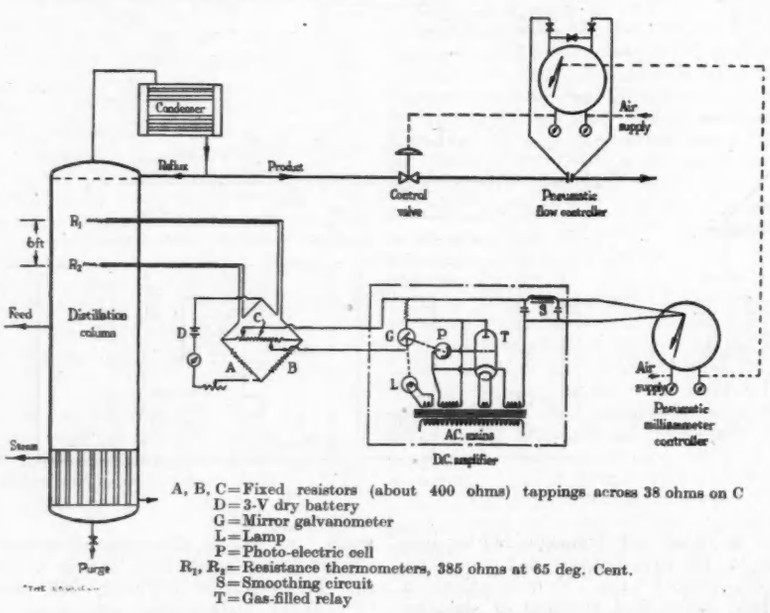
It must again be stressed that this is a very different matter from estimating whether or not it is economic to install automatic control in place of manual control on a plant which could be operated by either. The plant designed for optimum use of automatic control would be practically impossible to run on manual control; the latter could not be relied on to maintain sufficiently close control of the process to make it successful or safe.

In working out the economic balance for any plant, however, allowance must be made, when considering the possible reduction in labour, for the fact that a certain minimum of labour is always required to deal with emergency conditions.

It should be remembered that the closer plant design comes to utilising fully the possible performance of the control system, the more it will be necessary to improve the individual control installations. This problem of plant design can only be solved when sufficient process data and control experience are available, and it must be the responsibility of industry to accumulate this knowledge and make it available to workers in the control field.

Complete Electrical Control System.—At present in the chemical industry there are a considerable number of electrically operated alarms and straight on/off devices, but there are very few controllers. The almost universal use of the air-operated controller is not fortuitous, but is a direct result of several causes.

(*a*) In the early days the fluid-operated diaphragm valve was found to be cheap to install and easy to maintain, and it still remains



A, B, C = Fixed resistors (about 400 ohms) tappings across 38 ohms on C
D = 3-V dry battery
G = Mirror galvanometer
L = Lamp
P = Photo-electric cell
R_1, R_2 = Resistance thermometers, 385 ohms at 65 deg. Cent.
S = Smoothing circuit
T = Gas-filled relay

Fig. 1—*Temperature-Gradient Control of Distillation Column*

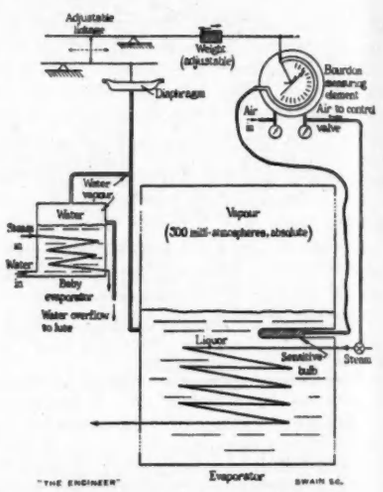


Fig. 2—*Automatic Control of Concentration of an Aqueous Solution in an Evaporator*

* Abstract. Paper by J. W. Broadhurst, T. C. Broderick, A. W. Foster, G. E. Wheeldon (Imperial Chemical Industries, Ltd.). I.E.E. Convention on Automatic Regulators and Servo Mechanisms, May 19–22, 1947.

superior, except on very large valves, to the electrically operated valve.

(*b*) Developments in the controller mechanism were naturally adapted to use the diaphragm valve.

(*c*) At the same time, requirements of flameproofing made air operation preferable to electrical operation in many installations.

(*d*) To deal with the long process lags normally encountered in industry, the air-operated system was simpler to design and to build.

So much for the historical side, but with the advent of such devices as the electronic self-balancing potentiometer, which will probably largely replace its mechanical counterpart within the next decade, an opportunity occurs for the appearance of a completely electrical control system. A large number of the primary measuring elements used in the chemical industry are electrical, and electrical measuring instruments and recorders are widely used. It is suggested that there is possibility here for the electrical engineer to develop electrical control equipment. The integration, differentiation, &c., of the deviation from set-point could be carried out on the output from the measuring element, and then the output, with all the required control terms thus added electrically, could be fed into a power amplifier to derive the final signal required to operate the controlled valve. By standardising the output voltage and impedances of all primary elements at some suitable values, all controllers could be made to a standard design. This, coupled with the fact that the connection between primary measuring apparatus and controller is electrical, would result in several advantages :—

(*a*) The cost of the controller would be decreased owing to standardisation.

(*b*) On a given works less spare controllers would need be carried.

(*c*) The conversion from indicator (or recorder) to controller becomes a simple matter.

(*d*) If necessary, a primary measuring system from one manufacturer could be connected to another manufacturer's controller.

The first three points need no elaboration. In connection with the fourth point, the occasion sometimes arises where it is necessary to purchase the measuring system and the controller from two different manufacturers, and then to combine them on site. Experience has shown that this is a complicated and costly process so far as the user is concerned, involving him in much detailed work before the combined system is finally in operation.

One further advantage of an electrical control system has not yet been mentioned. On batch processes it is frequently necessary to get the batch to a given control point as quickly as possible, hold it there for a given period, and then change to a higher (or lower) control point again as quickly as possible, and hold it at that point until the end of the batch. All this may have to take place in a tile-lined jacketed vessel, which has a poor heat transfer and hence a long thermal lag, under reaction conditions which may be violently exothermic or endothermic at different stages. Thus we have conflicting conditions. For the rapid rise to control point a proportional-plus-derivative controller is required ; once control point has been reached a floating component is required to correct for the droop which would occur if the reaction becomes exothermic or endothermic ; whilst when the second rise to a new control point is required, the floating term would again have to be eliminated. In an electrical system it would appear that the switching in and out of the floating term could be accomplished easily and neatly.

Electrically Operated Valves.—Unless a completely new type of electrically operated valve is developed, which will be economical to install and which will give satisfactory service with no more maintenance than is normally given to the diaphragm type, it is extremely unlikely that such valves will be employed in the chemical industry to any extent. In the design of such a valve, detailed consideration will have to be given to such points as :—

(*a*) Simple design to aid cleaning and maintenance.

(*b*) Resistance to external corrosion by plant atmospheres.

(*c*) Large operating force, combined with rapid action and accurate positioning.

(*d*) Flameproof certification without the employment of too heavy a construction.

[Descriptions of a number of controllers are given in appendices to the main paper, from which are abstracted the following two examples.]

A Temperature-Gradient Controller

The quality of product from industrial distillation columns is usually controlled by manipulating the reflux/overhead-take ratio to keep a constant overall temperature gradient. Thus in a column in which the liquid is kept at constant temperature by regulating the heat directly applied to it, the column top would be kept at a definite temperature by regulating the amount of cold distillate returned to the column as reflux.

When the distillation process involves the separation of components of the feed which boil within a few degrees of each other, the problem of maintaining the necessary absolute accuracy, under industrial conditions, becomes very difficult. On the laboratory scale a differential measurement, using a specially pure sample of distillate as reference, is frequently used. A modification of this has been adopted in the temperature controller described here, in which the temperature difference chosen is that between two points in the column above the feed point, *i.e.*, the temperature gradient over a given section of the column is controlled by regulating the cold reflux supply.

The column in question handles about 300 gallons an hour of feed boiling at about 70 deg. Cent. under reduced pressure, with a maximum temperature gradient of about 0·3 deg. Cent. per foot. Two matched resistance thermometers, with bulbs 10in long and of about 150 ohms fundamental interval, are positioned in sheaths inserted through the side of the column and 6ft vertically apart. The instrument problem then becomes the provision of a temperature controller, which will give fully stabilised control of a temperature difference of about 1·5 deg. Cent. Other likely developments call for a much higher sensitivity.

None of the established temperature controllers using pneumatic control mechanism could be obtained with sufficiently narrow range for this application. Electronic amplification was strongly indicated and was most readily available in the Tinsley d.c. amplifier. This apparatus, first described by D. C. Gall,† employs a relatively insensitive reflecting galvanometer and photo-cell to control the phase of the grid voltage of a gas-filled relay acting largely as a rectifier. Negative feedback is introduced to stabilise and give more or less null-potentiometer characteristic to the circuit. The smoothed output, which may be as high as 30mA, is measured on a recording milliammeter. In the present instance the milliammeter is fitted with the standard Stabilog proportional and reset pneumatic controlling mechanism.

Fig. 1 shows the general lay-out of the complete controller, including the bridge circuit formed by the two resistance thermometers and adjacent fixed resistors. The latter are adjusted to balance the bridge when the thermometers are at exactly the same temperature. Current through the bridge is kept at the value which gives the required full-scale range on the recording controller. Although for immediate purposes 5 deg. Cent. range is found suitable, ranges as low as 0·1 deg. Cent. are known to be feasible.

It will be noted from the diagram that the temperature difference controller does not directly control the reflux rate. In practice, it is preferable to control the product take-off, and for this purpose a flow controller is employed to operate a diaphragm motor valve in the product line. This will maintain a steady rate of flow of product from the column, independent of fluctuations of feed, boil-up rate, column and line pressures, &c., at the value determined by the set control point. Since changes are necessary, however, in the product take-off rate to produce (inverse) changes in the amount of reflux, the temperature difference controller is coupled pneumatically to the flow controller, so that the control point of the latter is reset to the extent needed to give the required constant temperature difference.

In spite of its apparent complication, this controlled system has proved convenient, and capable of keeping a temperature difference of 1·5 deg. Cent. constant to 0·05 deg. Cent. under industrial plant conditions. Although the precaution was taken of mounting the amplifier on a main column of the plant structure, there is no evidence that the apparatus was hypersensitive to vibration. During eighteen months' continuous use the only maintenance required has been replacement of one galvanometer lamp bulb.

Automatic Control of Salt Concentration in an Evaporator

A common arrangement of chemical plant uses a system of evaporators in a continuous process to concentrate an incoming weak solution. These are often controlled to give an unsaturated solution of constant concentration at a rate which varies to suit immediate process requirements. The following description‡ indicates two stages of development of a method which has been used for some ten years to control such a concentration automatically.

The application has been to evaporators working at pressures below atmospheric, of the order of 200–600 milli-atmospheres (absolute). A steam-heated calandria is used to provide the heat for evaporation, and the concentration is adjusted by variation of the steam rate. The level of liquor in the evaporator and the pressure in the vapour space can be kept constant by conventional controllers. The liquors leaving the evaporators are nearly saturated aqueous solutions at about 80–100 deg. Cent.

For manual control of the plant the concentration is usually measured, when required, by taking a sample of the liquor, allowing it to cool slowly, and noting the temperature at which crystallisation begins. This method is inconvenient, subject to many sources of error and involves a time lag. The difficulty of developing an automatic control system was almost entirely that of finding a suitable property of the liquor which could be measured as a function of concentration. The measurement of such a property had to be continuous, simple and dependable, and to involve the minimum use of measuring equipment inside the evaporator (where it would be inaccessible and subject to corrosive conditions). The measuring mechanism had also to be capable of being used with some available type of control equipment. The most suitable properties to measure to achieve these objects are specific gravity and boiling-point elevation. The first of these involves the use of comparatively complicated equipment inside the evaporator, and the achievement of sufficient sensitivity and dependability in a violently boiling liquor promised to be difficult, so the methods based on temperature measurement were used.

The boiling point of a solution depends upon the pressure above it and upon its concentration. Concentration is thus a function of boiling point and pressure. This function has to be measured and maintained constant. This has been done in two ways. The first method was devised to suit the control instrument mechanism then available ; the second is an adaptation to suit what is now standard control equipment.

First Controller Arrangement.—The first controller arrangement to be used is shown in Fig. 2. The bulb of a mercury-in-steel temperature controller measures the temperature of the liquor boiling in the evaporator, *i.e.*, boiling point at working pressure. A flexible diaphragm is subjected to the same working pressure, being connected to the vapour space above boiling water in a specially provided "baby evaporator" vented into the plant vessels. An adjustable lever system is used as a mechanical linkage between the pressure diaphragm and

† *Journal*, I.E.E., 1942, 89, Part II, page 434.

‡ Contributed by J. D. Tallantire.

the thermometer movement. This linkage is so adjusted that a change in pressure and the boiling-point change which corresponds to it produce equal and opposite effects on the controller impulse system. This setting is obtained by trial and error, the record of achieved concentration being used as a guide. Deviations from the present concentration, detected as independent temperature or pressure variations, are corrected through operation of the steam valve by a pneumatic proportional-reset controller mechanism.

The sensitive element of the temperature controller is a 6ft bulb mounted horizontally (in a pocket) in the liquor above the calandria. This thermometer has a range of 90–100 deg. Cent. and is sensitive to temperature changes of 0·01 deg. Cent. The pressure compensation in this arrangement is adequate over a range of ±50 milli-atmospheres from a prescribed setting, and manual adjustment of the compensating linkage is necessary to cover pressure changes outside this range and significant changes in barometric pressure. The system gave good results for several years with manual control of the pressure and level in the evaporator which permitted short-term pressure fluctuations over a range of ±20–40 milli-atmospheres.

Recorder Arrangement.—As stated above, concentration is a function of boiling point and

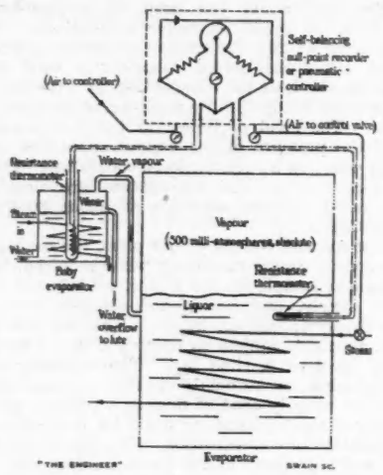


FIG. 3.—*Recorder-Controller for Automatic Control of Concentration of an Aqueous Solution in an Evaporator*

pressure. As the boiling point of pure water is a function of pressure alone, concentration of an aqueous solution can be measured directly in terms of the temperatures of the solution and of water boiling under the same pressure. If the rate of increase of boiling point with pressure is the same for the solution as for water over the pressure range in question, the difference in temperature between liquor and water measures concentration directly. This difference is measured by a differential resistance thermometer recorder with measuring elements in the evaporator and "baby evaporator." The "baby evaporator" is provided for this purpose and is steam-heated and fed with condensed steam. The arrangement is shown in Fig. 3.

In some cases the variation of boiling point with pressure is appreciably greater for the solution than for water. In such cases the same kind of resistance-thermometer circuit is used, but the liquor thermometer is so shunted that such proportionate rises in resistance of the two bridge arms as would be produced by a pressure change do not affect the measured difference.

Some ten years of experience, using a concentration record of this kind with a liquor-temperature record on the same chart, have shown that it is quite practicable to adjust the linkage between the pressure and temperature-measuring systems by trial and error to give good control of concentration.

Later Controller Arrangement.—The controller which has been described is an example of the development of a "measuring element" to fit an available controlling mechanism. At the time when this arrangement was devised, pneumatic potentiometer controllers were not in general use, but their availability has made possible a simpler controlling arrangement. This makes use of the differential resistance thermometer arrangement previously used only for recording. A null-point resistance thermometer bridge is incorporated in the usual type of air-operated proportional-reset potentiometer controller, which controls the concentration directly by means of the steam valve.

This control system has several advantages over its predecessor. It uses standard equipment with little modification, is compact and gives adequate pressure compensation over a wider pressure range without the need for special running adjustments. In addition, it is unaffected by barometric pressure changes.

The development of these controllers is a good example of the common procedure for arriving at a special automatic control system, in which a suitable physical measurement is selected and arranged to give an impulse suitable for an established type of automatic control instrument.

Track Renewal by Cranes on the L.M.S.

DURING recent years a considerable amount of progress has been made by the London, Midland and Scottish Railway Company in the technical development of its permanent way and in the methods of maintenance and renewal.

These developments were initiated under the auspices of the company's chief civil engineer, Mr. W. K. Wallace, some years before the recent war, when, with the development of high-speed traffic, it became apparent that steps would have to be taken to improve not only the strength and stability of the track, but also the methods of maintaining it. Furthermore, it was necessary to introduce methods of track renewal whereby the times of occupation of the track would be reduced to a minimum. The three principal measures taken to meet these conditions have been the use of flat-bottom rails, measured shovel packing and the renewal of track by crane. We have received from the company a report of the progress made in each of these directions, and have selected for description the method which has been adopted for renewing lengths of track by the use of cranes.

The renewing of plain track in pre-assembled lengths by means of cranes was first tried out on the L.M.S. in 1938 on the Peterborough line. Wartime difficulties prevented an extension of the method until 1945, when suitable equipment again became available.

There are two methods of renewing plain track by crane, one known as the two-crane and the other the one-crane method. With both methods the lengths of track (usually 60ft) are pre-assembled in some convenient small depot the rails, base plates and/or chairs being securely assembled and fastened to the sleepers in their permanent positions. The crane or cranes are then used to lift, convey and assemble the rails and sleepers on site with a minimum of manhandling.

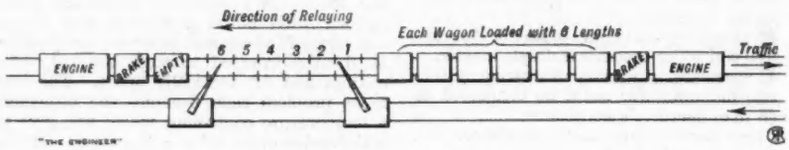
For the laying of the track complete possession is necessary of two tracks, one on which renewal is to take place and on which the material trains operate, the other on which the cranes operate.

TWO-CRANE TRACK LAYING

With the two-crane method, illustrated in the accompanying diagram, about forty men are usually employed, and the assembly of the material trains provides for two engines. One engine draws the wagons loaded with new materials and the other propels one empty wagon, the two trains being situated on either side of the first few lengths of track to be relaid. One crane lifts out the old track, conveys and loads it on to the empty wagon, whilst the other crane unloads and lays the new length of track into position in the line. As new material is unloaded from each wagon the track, new and old, is coupled up so that the empty wagon can be passed back from the new material train to the old material train. This procedure is followed until all the new track has been laid in and the old track loaded.

During the time between the lifting of the old track and the laying-in of the new the ballast beds are hacked up and the ballast levelled off to provide the proper bed for the new sleepers. The laying of each length of track is immediately followed up by bolting up fish-plates and correctly positioning joint sleepers. When the renewals have sufficiently progressed a ballast train is discharged on to the newly laid track, so that lining up and packing to a proper top can be dealt with currently. Immediately work is finished the lines can be opened to traffic, but with the usual speed restriction of about 15 m.p.h. Within a day or two of laying the track by this method and with gangs following up to consolidate the newly laid track, the company finds that it is usually possible completely to remove the speed restriction, depending upon local conditions.

During a recent demonstration on the L.M.S. of this method of laying track, fewer than forty men with two cranes, one 7-ton and one 10-ton capacity, laid ninety-six 60ft lengths of track



TRACK LAYING WITH TWO CRANES

in twelve hours, at the end of which traffic was immediately resumed. It has been established that 1000 yards of track, where complete possession of two tracks is possible, can be laid in in six hours, and the speed restriction of the usual 15 m.p.h. taken off completely twenty-four hours later.

With the one-crane method of re-laying sixty men would have been required for laying this length of track and the speed restriction of 15 m.p.h. would have been in operation for about a week.

The advantages of the crane method of re-laying are briefly as follows:—Greater speed of re-laying; overall time of track possession is reduced to a minimum; time over which speed restriction prevails is lessened; pre-assembly of track is carried out under conditions which ensure a good fitting-up of components by specialist staff; track components are less liable to maltreatment when laid properly assembled; reduced manual effort, and as old materials are being currently loaded up, tidiness of track is assured.

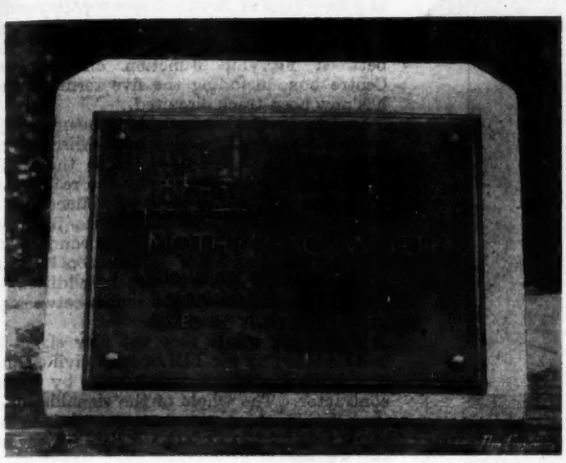
RENEWALS OF JUNCTIONS BY CRANE

Renewal of permanent way by the crane method is not only confined to plain track. In 1938 there was also tried out the principle of assembling junction work in the manufacturer's yard, loading it by crane to rail vehicles for conveyance to site and there offloading it for re-assembly on the actual formation. The extent to which the work can be fully assembled in the manufacturer's yard is necessarily limited by the dimension of the items in relation to the loading gauge. Where, however, it is impracticable for this or other reasons to secure chairs, &c., before they leave the yard, the required positions can be marked up in advance, thus saving time on the site. This method of renewing point and crossing work has been considerably developed and extended.

Timothy Hackworth

To remind posterity of Timothy Hackworth's association with early railway development in North-Eastern England, the L.N.E.R. has recently installed a commemorative plaque at Soho House, the building in which he lived and worked at Shildon. The plaque consists of a cast bronze plate, with raised letters and motif modelled in low relief, and is shown in the accompanying engraving.

It is not easy to assign to Timothy Hackworth his just position in locomotive history. That he was one of the great pioneers is undoubted, but it is probably an exaggeration to say, as D. K. Clark said, that "No single individual in this country had, up till the year 1830, done so much for the improvement of the locomotive and for its establishment as a permanent railway motor as Mr. Timothy Hackworth." He was connected with locomotives from their beginning, working side by side with Hedley and Stephenson, and it is impossible to say now how much was due to him and how much to them. His title to fame rests really



PLAQUE COMMEMORATING TIMOTHY HACKWORTH

on the famous "Royal George" of 1827, depicted on the plaque, certainly the most notable engine of its day. Its predecessors on the Stockton and Darlington Railway were all four-wheelers, following the design of "Locomotive No. 1." They were barely up to their job, and Hackworth, who, on Stephenson's recommendation, had been made engineer to the company, designed and built a six-coupled engine with a larger and better boiler. At the same time he got rid of the chains that Stephenson used for coupling and employed "side rods." He also improved the blast. The engine steamed well and was a success from the first. Indeed, it is claimed that it got the company out of financial difficulties and secured the steam locomotive in its position. Another engine with which Hackworth's name is associated is the ill-fated "Sanspareil," which had to be withdrawn from the Rainhill Trials of 1829 owing to a defect, and yet another, the passenger engine "Globe," which blew up after nine years of successful work.

Timothy Hackworth was born in 1786 and died in 1850. He was a man of striking appearance and of very upright character. His education had been such as a village school could give, but, like Stephenson, he had improved it by study and especially by experience. He built at Shildon many engines that are known to historians, and left behind him when he died the affection and respect of his workpeople and their families, and a reputation that places him in the front rank of early locomotive designers and builders.

THE LONDON, MIDLAND AND SCOTTISH RAILWAY COMPANY has placed a contract with Charles Booth and Son, Bradford, Yorks., for the reconstruction of the retaining wall at Elizabeth Dock, Maryport, Cumberland.

Colleges of Technology and Technical Manpower*

To restore and enhance our industrial position and to attain full employment and an improved standard of life, it is essential to ensure that scientific and technical research is not only carried out as widely and as intensively as possible, but is applied promptly to production.

For this purpose there must be an adequate output of qualified scientists and technologists which has been estimated to be at least double the present output.

The major technical colleges (Colleges of Technology) could make a substantial contribution of some 5000 to 7000 qualified technologists and scientists a year by providing, if not already doing so, courses in technology of a standard equivalent to that attained in university courses.

Effectively to use this potential capacity for the training of qualified technologists and scientists and to attract a fair proportion of students of high ability to the courses in the colleges of technology, it is essential that a qualification should be available which has both national and international currency. In general, the only qualification which fulfils this condition is the bachelor degree. Furthermore, a bachelor degree is the only qualification from which a successful student may proceed to higher degrees.

The regional organisation of higher technological education is a matter of the utmost importance as is also the complete implementation of the recommendations of the Minister that an Advisory Council and an Academic Board should be set up in each of the ten regions into which England and Wales is divided for the purposes of technical education. Each Regional Academic Board will include, amongst others, representatives of the universities and of the colleges of technology.

University degrees are awarded in a limited number of technological studies, both at the universities and at those departments of colleges of technology recognised by the local university, but there is a wide range of nationally important and educationally sound courses in technology for which no adequate award is available. These courses exist or can be provided in departments of colleges of technology. Therefore the Regional Academic Boards should immediately consider how far the local university is prepared to extend its recognition to cover departments of colleges of technology providing technological courses which are of university standard. In this way the local university and the colleges of technology will collaborate in meeting local and national needs and the students in technology will be able to receive a degree award.

The Minister of Education should immediately proceed to establish the National Council of Technology which will be representative of the ten Regional Academic Boards and which will, after consultation with the University Grants Committee, advise the Minister on the provision and extension of higher technological studies from the national point of view. The local regional organisations will look to the National Council of Technology for guidance on broad principles and on the national implications of local schemes. In addition the National Council will have to consider whether a new organisation for granting degrees is needed, and whether in special circumstances it should itself seek the power to confer degrees in technology.

These are matters of a national character and the National Council of Technology should be set up without further delay.

For certain industries of great importance but requiring only a relatively small number of technologists, National Colleges with adequate equipment should be developed with the utmost speed by the Minister of Education in co-operation with the respective industries.

Research in colleges of technology, and also the training of post-graduate technologists in research methods, should receive every encouragement. In general, the research should be applied in character and done in collaboration with the industry and its research association. Only in exceptional circumstances should research of a secret character for a specific firm form part of the work of a college of technology.

The Minister of Education, in collaboration with the universities, should consider advising students, who wish to undertake research work after their bachelor degree, to do their National Service Training on leaving the secondary school, so that they may start their research work immediately after satisfactorily completing their degree courses. Most of the present ex-Service students are anxious to qualify and to enter employment, and do not view with favour a further year devoted to research, but the present position is abnormal.

The Minister of Education should ask the Burnham Committee on Salaries to give special consideration to the formulation of improved scales of salaries for staffs employed in departments of colleges of technology recognised as providing courses equivalent in standard to university degree courses. As these lecturers should be able to enter industry for refresher periods, the salary scales must be considered not only in relation to those in the universities, but also to those in industry.

Only in this way will the Minister's desire for highly qualified staffs in colleges of technology be fulfilled.

The Minister of Education should also amend, if necessary, the Teachers' Superannuation Act to provide for lecturers spending "refresher" periods in industry.

The Minister of Education should extend the number of, and should more extensively publicise, the Technical State Scholarships available for students wishing to study technological subjects to a high standard.

Consideration should be given to the establishment of loan funds in colleges of technology. From such funds under specified conditions, a worthy student who might otherwise have to give up his training owing to unforeseen financial difficulties could borrow.

The Governing Bodies of the colleges of technology should be given reasonable freedom in directing the affairs of the colleges and in incurring expenditure within the estimates submitted to and approved by the providing authority. The Governing Bodies must be influential and fully representative of the industries for which the college provides training.

Note.—This report has been concerned solely with the relatively few major technical colleges (colleges of technology) in the country which provide technological courses of a standard comparable with those in the universities, and to which we may look for the training of qualified technologists. In the course of the investigation, it has been suggested that another report should be prepared dealing with the training of technical assistants and craftsmen in the large number of technical colleges excluded from consideration in this report.

* Report adopted by Parliamentary and Scientific Committee (subject to dissent on some points by representatives of Institute of Physics). Summary of Recommendations.

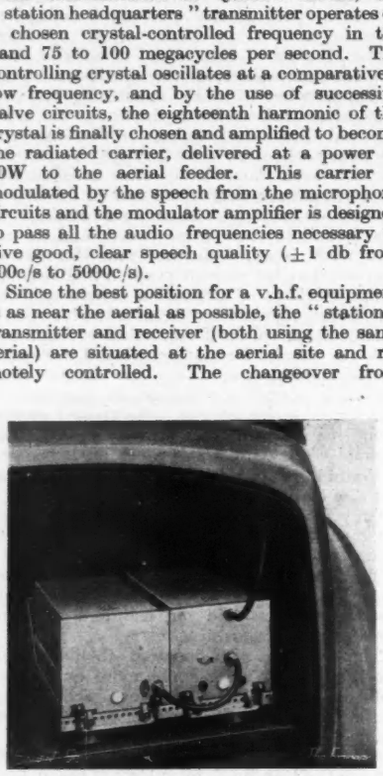
COAL CLEANING PLANTS.—A written reply by the Minister of Fuel and Power states that between the end of 1945 and the end of 1946, thirty-nine coal cleaning plants, including washeries, were installed in the United Kingdom, and that in the same period forty-one plants were dismantled. The total number of plants at the end of last year was 542, and during that year 47·4 per cent of the total output of saleable deep-mined coal was cleaned before sale.

Police Radio Equipment

As a result of the Home Office policy of providing the police forces of this country with up-to-date equipment, certain British radio manufacturers were invited, some months ago, to submit samples of their post-war radio equipment suitable for use in police cars. After exhaustive tests by the Home Office, the equipment manufactured by Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex, was amongst the sets that were selected for installation in police cars on a country-wide basis in Great Britain. This equipment was demonstrated recently in London between a control station at the English Electric Company's Offices at Queen's House, Kingsway, and a police car patrolling the London area.

As demonstrated at Queen's House, the "station headquarters" transmitter operates on a chosen crystal-controlled frequency in the band 75 to 100 megacycles per second. The controlling crystal oscillates at a comparatively low frequency, and by the use of successive valve circuits, the eighteenth harmonic of the crystal is finally chosen and amplified to become the radiated carrier, delivered at a power of 50W to the aerial feeder. This carrier is modulated by the speech from the microphone circuits and the modulator amplifier is designed to pass all the audio frequencies necessary to give good, clear speech quality (±1 db from 200c/s to 5000c/s).

Since the best position for a v.h.f. equipment is as near the aerial as possible, the "station" transmitter and receiver (both using the same aerial) are situated at the aerial site and remotely controlled. The changeover from



RADIO EQUIPMENT IN CAR

"send" to "receive" is effected by a relay-operated from a press switch on the distant microphone. Full control is possible over ordinary telephone lines up to a distance of 3 miles and two or three widely separated transmitters can be controlled from the one remote position for "diversity" transmission, a technique used to combat fading and black-out of signals, due to the presence of steel buildings or other obstructions.

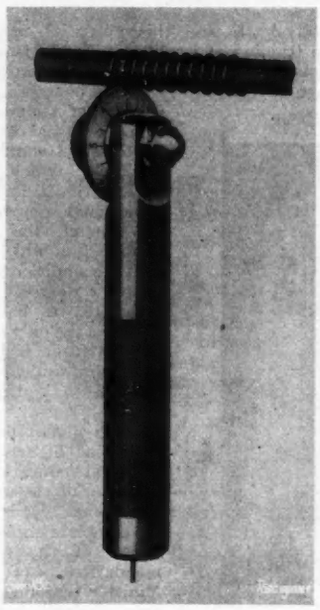
The mobile unit used in the demonstration is a complete radio telephone set working on the same spot frequency in the 75–100 megacycle per second band as its headquarters transmitter, but operating from the car 12-V battery. The transmitter and receiver are fitted together on a light metal rack mounted on shock absorbers and installed in the luggage boot of the police car, as illustrated herewith. The whole equipment is controlled from a small unit on the dashboard of the car, the loudspeaker and the hand microphone being conveniently placed for the use of the operator seated alongside the driver.

A traffic control loudspeaker can be fitted on the outside of the vehicle, and by operating a switch on the dashboard unit the operator is able to control this speaker from his hand-microphone.

Like the 50-W headquarters transmitter, the mobile unit is crystal controlled and delivers 10W to the aerial feeder. The receiver is a highly efficient crystal-controlled double superheterodyne with a low noise level, giving good quality signals that are claimed to be clearly intelligible through the worst interference. The same type of receiver is also used with the 50-W equipment. A single roof-mounted flexible aerial is used on the car for transmission and reception.

A Spring Winding Tool

THE photograph which we reproduce below shows a particularly useful little spring winding tool which has been developed by the Acru Electric Tool Manufacturing Company, Ltd., 123, Hyde Road, Ardwick, Manchester, 12. With it tension and compression springs can be wound from wire of any thickness up to 2½mm



SPRING WINDING TOOL

with precision and in a quick, simple manner.

With this tool the wire is fed through the handle and passes on to the former through a hole drilled through a cross shaft screwed in the head. The wire is tensioned between a renewable fibre disc on the end of the shaft and a graduated cam disc adjacent to the head. Tension on the wire can be easily adjusted, both before or during the winding operation, by the turning of a knurled knob at the end of the cross shaft. The distance between the separate turns of the spring can be pre-selected and fixed by the setting of the cam disc, which bears against the former as the wire is wound upon it.

It will be appreciated that the new tool provides, not only a simple and accurate means of winding springs, but also one in which the operator is not exposed to the danger of cut and torn hands.

New Signal-Box at Aberdeen

PARTICULARS have been received from the London, Midland and Scottish Railway Company of the largest resignalling scheme carried out in Scotland since the modernisation of St. Enoch Station, Glasgow, in 1933. This work was completed in April last, when the old Denburn South Junction signal-box at Aberdeen was closed and replaced by a new box, Aberdeen South, with modern signalling and continuous track circuiting. The whole of the signalling at the south end of the Aberdeen Joint Passenger Station is maintained by the L.M.S. on behalf of the L.M.S. and L.N.E.R. Joint Committee.

The old 240-lever frame at the Denburn South Junction box was some 105ft long and was one of the largest of its kind. When this frame, together with much of the other signalling equipment, was due for renewal some time ago, it was decided to resignal the whole area controlled by the box. Now, by employing modern methods and equipment, it has been possible to bring the working within the compass of a 150-lever frame of the L.M.S. standard type at the new Aberdeen South box. At the same time, additional operating facilities have been provided to enable the large and increasing volume of traffic at Aberdeen to be dealt with expeditiously.

The new signal-box, a brick structure of modern design, is 46ft shorter and the floor is 7ft 6in lower than the old box. It is equipped with two illuminated diagrams and up-to-date amenities. By the use of multi-lamp route indicators, the number of running signals has been reduced by one-third.

Electric signal lighting has been installed and each signal is now correctly positioned in relation to the line to which it applies, to give greatly improved sighting from the footplate. In the new box the main and subsidiary signal arms are operated by the same lever by means of a new type of electrical selector designed by the L.M.S. signal and telegraph engineer, and manufactured at Crewe. The whole area between Ferryhill Junction and Aberdeen Centre box, including the five terminal bays, has now been track circuited.

Owing to the complicated nature of the station layout difficulties have arisen in the past when the normal routes to the various platforms were obstructed by the rear portion of a train standing foul of connections to adjacent lines. These difficulties have now been overcome by signalling the running lines for both-way instead of unidirectional working at the station approaches. In addition, use can be made of alternative routes between any two points.

We are informed that the new signal-box was designed by the L.M.S. chief civil engineer and built under his supervision by a local contractor. The whole of the signalling other than the signal-box structure, was designed and carried out by the signal and telegraph engineer and his staff.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

NOMENCLATURE OF COMMERCIAL TIMBERS (INCLUDING BOTANICAL NAMES AND SOURCES OF SUPPLY)

B.S. 881 and 589. A revised edition of the standards for the Nomenclature of Timbers has just been published by the British Standards Institution. Previously the nomenclature of softwoods was included in B.S. 589 and the nomenclature of hardwoods in B.S. 881, issued as separate documents. These have now been combined in one publication, though retaining their separate B.S. numbers for the two parts. It should be clearly understood that the subdivision of commercial timbers into these two grades of hardwoods and softwoods follows the definitions of these terms as given in B.S. 565, based on a long-standing custom of the trade. They refer to the botanical group to which the timber belongs and do not refer to the physical properties. The standard timbers listed are intended to cover all hardwoods and softwoods of economic importance in Great Britain. 'A number of additions have been made to include timbers which have come on to the home market in recent years. The principle of endeavouring to establish a single standard name for each timber and restricting that name to one timber only has, in general, been maintained. The standard gives for each timber information about its botanical species, sources of supply and other commercial or botanical names by which the timber may have been known. Where appropriate, some general remarks on the different timbers are also included. There is a comprehensive index for both the standard and botanical names which enables any timber to be readily traced. In an appendix there are included a few timbers which have recently been imported into this country on an experimental scale, but which have not yet become established as standards. There is also an appendix listing the abbreviations for the authors of the botanical names. The new publication will be invaluable to all concerned with the technical use of timber. Price 7s. 6d.

Disposal of Chemical Warfare Ammunition at Sea

We are informed by the Sea Transport Division of the Ministry of Transport that two ships recently left British ports carrying nearly 19,000 tons of chemical war ammunition to be sunk in water over 300 fathoms deep, with their dangerous cargoes.

The "Empire Lark," which was formerly the German-owned ship "Kirsten Miles," with 8000 tons of ammunition on board, left Barry, after loading at Barry Docks, on Thursday, July 24th, and after being towed some 300 miles by the salvage tug "Dexterous" under the escort of the Royal Naval Frigate H.M.S. "Tremadoc Bay," was scuttled on Sunday, July 27th, at 6.57 p.m., at a position 47° 55′ N and 9° 17′ W. Her place at Barry was taken by the "Thorpe Bay," in which a further 2325 tons of ammunition is being loaded. Meanwhile, the "Leighton," a former ship of the Lamport and Holt Line, loaded at Cairnryan, and left yesterday, Thursday, August 7th.

The loading of the "Empire Lark" was a long and difficult process, as the ammunition had to be conveyed to the loading point at the Barry Docks from dumps in various parts of the country, where it had been stored in the care of various Service departments. The work was delayed by the very severe weather in the early part of the year, the effect of which was felt for a considerable time afterwards. Further delays were caused in the careful inspection of the ammunition and containers, by the discovery of what is termed "leakers," or containers from which poisonous gas was escaping. These were generally put aside and were the last to be stowed in the hatches.

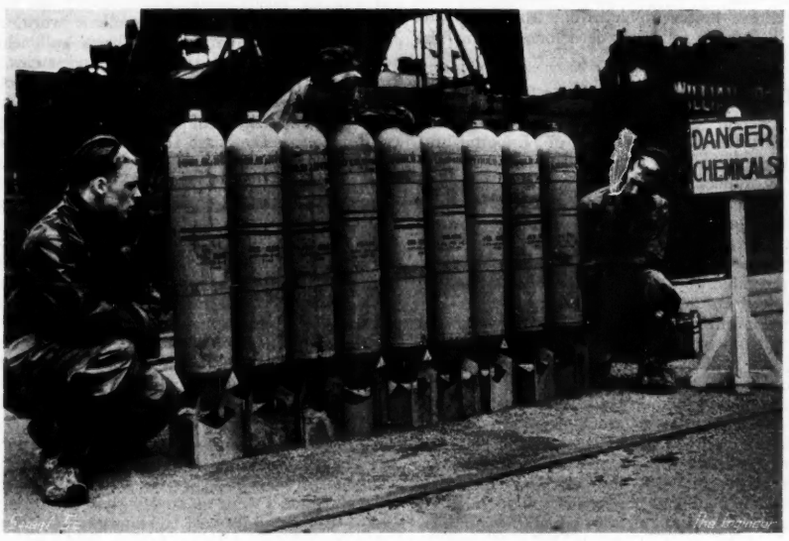
The accompanying engravings show some of the ammunition, including typical bombs, and the containers in the hatches. In order to enable as much chemical ammunition to be disposed of as possible, the ships, which were either too old for further service or those for which the cost of repair work would have been out of all proportion to the useful life of the ships, more than one of which were former German ships, were stripped of all surplus or useful equipment. Thus, winches, derricks, and furniture were removed, along with all useful fittings. The actual loading was carried out in a manner similar in every way to that which would have been adopted had the vessel been proceeding on a normal voyage. The scuttling charges were fitted in place and sealed by the Royal Navy, in conjunction with the technical officers of the Sea Transport Division of the Ministry of Transport. The charges are so arranged that they can be touched off electrically by the masters from boats at safe distances from the ships. As already mentioned the ships are all towed to sea under the escort of a naval vessel.

The crews of the ships to be scuttled only take with them the minimum of personal equipment, as they abandon ship on reaching the scuttling position, and return to port in the naval ship. The ammunition so scuttled could not, we are informed, be disposed of by burning or neutralising, and it would have constituted a menace if it had been dumped overboard, as may safely be done with selected explosives, as its poisonous contents would have escaped and damage to fishing grounds would have inevitably resulted. Such dumping of chemical warfare ammunition might also have proved dangerous to ships and a menace on the seashore.

So that it cannot rise to the surface again the material is carefully stowed into the ships' holds, and the hatches are then battened down. At the depth of sea mentioned it is expected to be quite safe. The two ships referred to bring the total of vessels so far used for this purpose since September, 1945, to twelve, and so far a total of 72,330 tons of chemical ammunition has been disposed of in this way.

The previous scuttlings were September, 1945, "Empire Simba" and "Empire Cormorant," 8032 and 8383 tons respectively; October, 1945, "Wairuna," 8432 tons; December, 1945, "Botlea," 6152 tons; August, 1946, "Empire Peacock," 8914 tons; September, 1946, "Empire Nutfield," 1982 tons; October, 1946, "Kindersley," 2074 tons; November, 1946, "Empire Woodlark" and "Lanark," 4348 and 2661 tons respectively, and February, 1947, "Dora Oldendorff," 2507 tons. The operation we have described will be continued until all dangerous ammunition has been disposed of.

LOADING A CARGO HATCH



GAS BOMBS

STOWING LEAKING AND BROKEN CONTAINERS

Industrial and Labour Notes

Neurosis Among Factory Workers

A report on "The Incidence of Neurosis Among Factory Workers" has just been issued by the Industrial Health Research Board of the Medical Research Council, and published by H.M. Stationery Office, price 1s. 3d. It gives the findings of a survey carried out at various times between 1942 and 1944 by teams working in the Midlands and in the London area under the direction of Dr. Russell Frazer and Dr. Elizabeth Bunbury.

The investigation was made amongst over 3000 male and female workers in thirteen light and medium engineering factories and the report indicates that 10 per cent (9·1 per cent of the men and 13 per cent of the women) had suffered from definite and disabling neurotic illness, and a further 20 per cent (19·2 per cent of the men and 23 per cent of the women) had suffered from minor forms of neurosis during the course of six months. Neurotic illness, it was found, caused between one-quarter and one-third of all absence from work on account of illness, and was responsible for the loss of 1·09 per cent of the men's possible working days, and of 2·40 per cent of the women's. This loss, it is computed, was equal to an annual absence of three working days by every man studied and of six days by every woman.

It is pointed out in the report that the factories chosen were only approximately representative of part of the engineering industry and it was possible to study only 80 per cent of the random sample selected. The conclusions reached indicate that it was not the purpose, nor the outcome, of the inquiry to show how neurotic illness can best be alleviated. It is, however, implicit in many of the findings that measures tantamount to good welfare and social work, both within and outside the factory, would be beneficial in alleviating and preventing neurosis, as would also, presumably, more extensive facilities for the medical treatment of neurotic illness than were available during the war.

The report admits that the figures quoted—over 25 per cent of sickness absence accounted for by neurosis and 10 per cent of the workers examined having suffered from disabling neurosis—cannot be applied, without reservation, to peacetime conditions of industry. It says, however, that the fact that during the period of survey few of the conditions notably peculiar to war were operative gives these figures wider relevance than might otherwise appear. In these days of under production and manpower shortage, it is suggested that industry cannot afford "to neglect the disturbing implications of the report."

Trade Disputes

There was some increase in the number of industrial disputes leading to stoppages of work in the United Kingdom in June, compared with the preceding month. The Ministry of Labour records that 151 stoppages were reported as beginning in June and that at some time during that month, eighteen stoppages which had started earlier were still in progress. These 169 stoppages involved, directly and indirectly, 59,100 people and accounted for an aggregate loss of 210,000 working days. During May, 129 stoppages were in progress, involving 70,200 workers, and resulting in a loss of 182,000 working days.

Of the stoppages of work, through disputes, known to have been in progress at some time in June, the coal-mining industry accounted for 100, involving over 34,000 workers, and resulting in a loss of 91,000 working days. There were thirty-three stoppages in the metal, engineering and shipbuilding industries, involving 6900 workers, and resulting in a loss of 28,000 working days.

In the first six months of this year, 972 industrial disputes leading to stoppages of work were reported to the Ministry of Labour. They involved, altogether, 341,600 people, and as a result of them it is estimated that there was an aggregate loss of 1,316,000 working days. In the corresponding period of 1946 there were 1184 stoppages reported, involving 288,200 people and causing an aggregate loss of 1,166,000 working days.

The Government and the Coal Miners

A meeting between the Prime Minister and other members of the Government and representatives of the National Coal Board and the National Union of Mineworkers took place in London on Wednesday of last week. According to an official statement, there was a full and frank discussion of possible ways of increasing the output of coal to meet the needs of the country in the present economic situation. The representatives of the National Coal Board and the National Union of Mineworkers, the statement added, expressed their desire and intention to make every possible contribution to that end, and all present at the conference undertook to examine as a matter of urgency the suggestions which had been raised.

The official statement made no comment on the suggestions put forward at the conference, but it is reported that the Government proposed that the daily shift should be extended by half-an-hour, making eight hours, exclusive of winding time. The question of increasing the manpower of the mines is also said to have been discussed.

Whitley Councils in H.M. Dockyards

Meetings of the Whitley Councils in H.M. Dockyards formed the subject of a question in Parliament last week to the Civil Lord of the Admiralty. It was suggested that regular periodic discussions with representatives of managements and workers might lead to the more efficient working of the dockyards, and that any suggestions of value which operatives desired to make could be utilised. As an alternative method of consultation, the questioner suggested that production committees might be set up in each of H.M. Dockyards.

In his reply, the Civil Lord of the Admiralty, Mr. Walter Edwards, stated that suggestions for improvements of methods and organisation of work in H.M. Dockyards were among matters which might be discussed at meetings of the yard committees. So far as the workpeople were concerned, the Whitley constitution provided that those committees might meet as frequently as once a month, if necessary, at the request of either the staff side or the official side. The yard committees in each of the three home dockyards, Mr. Edwards said, had met on four occasions during the past twelve months.

Dock Labour in Northern Ireland

The committee appointed by the Northern Ireland Ministry of Labour and National Insurance to enquire into the possibility of decasualisation of dock labour has now presented its report. The Northern Ireland Government, it is understood, has given preliminary consideration to the matter and has accepted the principle of decasualisation provided that an economical scheme can be worked out within the industry.

The committee recommends the introduction of a scheme of decasualisation embracing the ports of Belfast, Londonderry and Newry. It proposes, as a condition preceding the introduction of a scheme, that sufficient and no more than sufficient dock workers should be admitted to the Port Register, and that the numbers should be determined by a committee of employers' and workers' representatives at the ports concerned. The rates of wages to be paid at ports to which decasualisation is to be applied should be a matter, it is suggested, for settlement within the industry. Furthermore, the committee recommends a full investigation by both sides of the industry with a view to the removal of any practices which hamper the effective use of the labour force.

With regard to finance, the committee says that the decasualisation scheme should be self-supporting and that the cost should be met by contributions from the employers based on a percentage of the wages paid by them to the workers. It is recommended that the workers should be guaranteed a minimum wage of £4 5s. a week attendance money, all earnings, including overtime and week-end earnings, being set against such guaranteed minimum wage.

The Need for Increased Output

At the annual general meeting of the General Electric Company, Ltd., on July 31st, the chairman, Sir Harry Railing, devoted part of his address to what he termed "the vital necessity to increase production." That, he said, could only be achieved at this juncture by an increase of output per man-week. If it could be done in five days, so much the better, but if not, production would be reduced correspondingly, and everybody's standard of living would fall unfailingly with it.

In his personal view, Sir Harry continued, reductions of hours at this moment—desirable in themselves—would delay the recovery of the country. Increased standards of living, increased leisure, increased amenities could not precede, they could only follow increased production, for they were unobtainable except as a consequence of it. Increased output could only be achieved by increased effort from each worker—which term included workmen, staff and management—and by increased production facilities which included up-to-date buildings, machine tools, designs and planning. But it was evident, Sir Harry remarked, that whilst both were needed simultaneously the latter very often could only follow, rather than precede, the former during a time of general shortage.

Technical Colleges and Production

An adjournment debate on the subject of manpower and production took place in the House of Commons on Wednesday evening of last week, and, for the most part, the points raised emphasised once more facts with which many people in this country have become familiar since the end of the war.

One matter to which Mr. Sparks, who opened the debate, drew attention was the functions of the country's technical colleges. He expressed the view that they were not serving a full and proper purpose for the needs of this day and generation. Whilst the technical colleges were doing excellent work, Mr. Sparks did not think they were sufficiently concentrated upon the basic industries of mining, transport, engineering, textiles and iron and steel. He emphasised the necessity for the expansion of our technical colleges and institutes, saying that it was important that a larger number of students should be encouraged to enter. Mr. Sparks also commented on the fact that in 1945–46 there were 1,295,566 full-time and part-time students in the technical colleges—about 16,000 fewer than in 1937–38—and that whilst only 0·8 per cent of full-time day students were studying the technology of mining, there were 34·5 per cent studying art.

The Paymaster-General, Mr. Marquand, wound up the debate and, replying to the comments on technical colleges, suggested that possibly the decline in the juvenile population had not been taken fully into account. He suspected that part of the explanation was simply the decline in the number of young persons of an age to go to technical colleges. Mr. Marquand went on to say that the Government was doing its best to encourage the study of industrial technique in the colleges, and pointed out that there were courses in progress at 601 colleges, covering 100 specialised trades.

French Engineering News

(From our French Correspondent)

PARIS, August 1st

The Minister of Public Works has approved the dates set for electrification to be undertaken by the S.N.C.F. The Lyons–Geneva line will be finished in 1952, the Lyons–Marseilles line in 1953, and various suburban lines by 1955. The ten-year plan covers 2074km of line, of which 214km are suburban lines. Economy in coal will amount to 1,400,000 tons a year. When the programme is completed, electrified S.N.C.F. lines will amount to about 40 per cent of the total.

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The Petrol Regie plans to construct a pipeline between Toulouse and Bordeaux at a cost of 800 million francs.

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Steel production for June shows a reduction due to the strike of transport workers and miners. The output figures were 385,000 tons of pig iron, compared with 426,000 tons in May; 458,000 tons of crude steel, compared with 496,000 tons, and 307,000 tons of sheet steel, compared with 326,000 tons. Altogether the deficit is estimated at a minimum of 125,000 tons.

Although it would seem logical to reduce allocations in the same proportion, the automobile industry has been promised an increase of 20,000 tons and agriculture an additional 15,000 tons. Taking these promises and others into consideration, the remaining deficiency will probably amount to between 160,000 and 180,000 tons.

* * *

Important reconstruction and modernisation work was undertaken by the Schneider Company in 1946. Already eighty new dwellings are in use and over 200 now under construction will be available by the end of this year. In the course of 1946, steel production at Creusot was raised to a very high level, and in December, 1946, production reached the level attained in the most active month over the past twenty years. Prices imposed in this field result in a clear loss, but increased production has been pushed as far as is compatible with present installations and supplies. Increased activity in the mechanical branches has had a particularly important effect on orders for electrical equipment, the reconstruction of the railways and development of coal extraction.

At the Ugine steel plant, steel tonnage is now approaching 1938 production, and a particularly great effort has been made in aluminium production despite electricity shortages during the winter. The Saut-du-Tar Steel plant during the first five months of 1947 has registered its highest production yet. For the first time all available means have been utilised, but despite excellent production results the situation is adversely influenced by the low selling price. The Council's report shows that production during 1946 was better than in 1938.

In view of the possibilities for increasing consumption of tinplate the Société J.-J. Carnaud et Forges de Basse-Indre report states that the industry should be re-equipped with the most modern techniques, as outlined by the Monnet Plan. A second Martin oven is now functioning and hot rolling mills have been increased from five to fourteen. Production is still lower than pre-war, however, due to shortage of labour.

The Precision Machine Tool Construction Company aims at producing an ever widening range of machines, to which end the technical equipment of its workshops has been improved.

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The Locomotive Construction plant at Nantes, which is still undergoing repairs to war damage, repaired eighty-five locomotives and delivered twenty-two new locomotives in 1946. The first of the thirty 141-P steam locomotives will be delivered in the autumn, and work has started on the building of sixteen electric locomotives. One of the workshops at Nantes will be completely re-equipped in order to fulfil S.N.C.F. orders.

Notes and Memoranda

Rail and Road

RAILWAY RECEIPTS.—Traffic receipts of the four British main line railway companies and the London Passenger Transport Board in the four weeks ended July 13th, were £28,899,000. They showed a decrease of £1,062,000 compared with the corresponding four weeks of 1946.

THE CENTRAL LINE.—The Central Line of London's underground railway system last week completed its forty-seventh year, it having been opened for service on July 30, 1900. At that time, the line ran for a distance of 5¾ miles from the Bank to Shepherds Bush, and the trains were hauled by 40-ton electric locomotives. The line now extends from Greenford to Leytonstone, a distance of 19 miles, and within the next year or so is to be further extended to West Ruislip at its western end and to Loughton and Newbury Park at its eastern end.

RAILWAY CHARGES.—The Minister of Transport announced in the House of Commons on Tuesday last, that all fares, rates and charges on British main line railways are to be further increased, with effect from October 1st, next. Ordinary passenger fares and rates for merchandise by passenger train will be increased by 16⅔ per cent over existing rates, and other rail charges will be increased by 24 per cent. With these increases, railway charges generally will be 55 per cent higher than the pre-war level. In making this statement, the Minister said that the estimated deficit on Britain's main line railways this year would be £59,000,000.

TAR SURFACE DRESSINGS.—During the war the Road Research Laboratory of the D.S.I.R. issued a series of "Wartime Road Notes" dealing with matters of current practical interest to road engineers. This series has now been discontinued, but a new series of "Road Notes" has been started, which will similarly present those findings of research and experience that are of immediate interest to practising engineers. The first of the new series—Road Note No. 1, "Recommendations for Tar Surface Dressings"—is now available (H.M. Stationery Office, price 3d.). It is a re-issue of "Wartime Road Note No. 8," which has been brought up to date and certain recommendations referring to special wartime requirements have been omitted. It describes methods of applying surface dressings on waterbound macadam, concrete and on wood block paving, as well as on the normal bituminous surfacings. Experience has shown that, on an old bituminous road surface, a surface dressing composed of suitable materials correctly applied can be expected to have a useful life of at least three years and often longer. There are, in fact, many examples of roads, surface dressed before the war, that are still giving useful service, and it is not unreasonable to assume that under favourable conditions a well-laid dressing will have a life of at least five years.

Air and Water

THE LATE MAJOR J. L. BENTHALL.—We have noted with regret the death on Sunday, July 27th, at his home at Chislehurst of Major John Lawrence Benthall, who for many years was a director of Vickers, Ltd. He was seventy-nine years of age. He was educated at Harrow and served his apprenticeship as a shipbuilder with Samuda Brothers on the Thames. In 1889 he was appointed assistant manager of the firm. In 1892 he joined Vickers, Sons and Co., and three years later was made head of the armour department. He served on the Shell Committee in the 1914–1918 war, and on the naval side on the Control Commission for Germany and Austria. He was created C.B.E. in 1919. He was a Freeman of the Cutler's Company of Sheffield, and of the Worshipful Company of Shipwrights, and a member of the Institution of Naval Architects for some years. He retired in 1924.

THOMAS GRAY MEMORIAL TRUST.—The Council of the Royal Society of Arts offers two awards under the Thomas Gray Memorial Trust, the objects of which are "the advancement of the Science of Navigation and the Scientific and Educational Interests of the British Mercantile Marine." The first award is a prize of £50 to any person of British nationality who may bring to its notice an invention, publication, diagram, &c., which in the opinion of the judges is considered to be an advancement in the science or practice of navigation, proposed or invented by himself in the period January 1, 1942, to December 31, 1947. Full particulars should be furnished with each entry and also a brief summary covering the essential points of an invention. Where practicable a model or some other appropriate exhibit should be supplied with the entry. Entries which have already been considered by the judges in the years 1942–46 are not eligible for further consideration unless they have since been materially modified. Competitors must forward their proofs of claim, between October 1 and December 31, 1947, to the Secretary, Royal Society of Arts, John Adam Street, Adelphi, W.C.2. The second award, also of £50, relates to a "Deed of Professional Merit." The offer is open to any member of the British Merchant Navy for any deed brought to the Council's notice which, in the opinion of the judges to be appointed, is of outstanding professional merit. The period to be covered by the offer will be the year ending September 30, 1947, and the judges will proceed to consider their decision on or after January 1, 1948. Deeds of the type to be considered in connection with this offer may be brought to the notice of the Council by any person not later than December 31, 1947. They will not, however, be considered by the judges unless they have been endorsed by a recognised authority or responsible person able to testify to the deed to be adjudged. The Council reserves the right to withhold both awards or to make smaller awards or to divide the amounts into two or more awards at its discretion.

Miscellanea

GOVERNMENT FACTORIES AT GRANTHAM.—The Board of Trade announce that the surplus Government Factories Nos. 2, 3 and 4 at Grantham, occupied since 1945 by Grantham Productions, Ltd., are now available for re-allocation. Manufacturers who may wish to apply for them should address their enquiries, by August 15th, to the Distribution of Industry and Regional Division, Board of Trade, Millbank, London, S.W.1.

NUFFIELD METALLURGY SCHOLARSHIPS.—The Nuffield Foundation is to offer, during 1948, a limited number of fellowships and scholarships with the object of advancing research and training in extraction metallurgy. Citizens of Great Britain, the Commonwealth and Empire are eligible. The offer includes travelling fellowships, travelling post-graduate scholarships and vacation scholarships, and full particulars and application forms may be obtained from the Secretary, Nuffield Foundation, 12–13, Mecklenburgh Square, London, W.C.1.

GAS FROM UNMINED COAL.—American reports state that Belgian mine owners have been watching experiments in the United States in the burning of coal deep underground in Alabama mines and that a syndicate plans to start large-scale operations in Belgium. It is expected by this method to make gas directly from the burning coal, without mining it, with one-tenth of the labour force now required. Belgium has 1000 abandoned mines where the cost of digging the remaining steeply inclined seams is prohibitive. It is estimated that 70 per cent of this coal can be used by gasification process.

THE "FEREX" ELECTRODE.—A recent addition to the products of Murex Welding Processes, Ltd., Waltham Cross, Herts., is the "Ferex" electrode, which is a special ferritic electrode designed originally to supplement austenitic electrodes for the welding of tank armour. It is claimed that "Ferex" minimises hard zone cracking in high carbon and alloy high tensile steel, so that thicker plates and more difficult steels can be welded than was previously possible. The weld metal is said to be free from non-metallic inclusions, and good mechanical properties are claimed, especially under notch and embrittlement conditions, the Izod value being maintained at low sub-normal temperatures. Technical information about plate preparation and welding technique recommended for the "Ferex" electrode can be obtained from the manufacturers at the address given above.

BUILDING AND CIVIL ENGINEERING CONTRACTORS.—A recent Order in Council cancels the provisions in Defence Regulation 56 AB which require a registered building or civil engineering contracting undertaking to observe terms and conditions of employment which are neither more nor less favourable than those laid down in the industrial agreements or by arbitration, and the conditions as to hours of employment laid down in directions issued by the Minister of Works. Similarly, the power to revoke or suspend a certificate for breach of these conditions has been cancelled. It is still necessary, however, for a person who wishes to set up in business as a building or civil engineering contractor to be registered with the Ministry of Works and to make periodical returns of labour or other such information as may be called for. The Minister retains his power to refuse or revoke a certificate of registration in the case of a person who has been convicted of an offence under the licensing regulation.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Engineering and Marine Exhibition

Thursday, August 28th, to Saturday, September 13th.—London, Olympia.

Institute of Marine Engineers

Tuesday, September 9th.—85, Minories, E.C.3. Presidential Address, Sir Amos L. Ayre. Paper: "Steam Pipework Design in Ships." Lieut. (E) P. T. Hoath. 5.30 p.m.

Institute of Metals

Tuesday, September 23rd, to Friday, September 26th.—Annual Autumn Meeting at Glasgow.

Institution of Naval Architects

Tuesday, September 23rd, to Friday, September 26th.—Autumn meetings at Portsmouth and Southampton

Works Management Association

Friday, October 3rd.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester. Discussion, opened by A. P. Young.

Catalogues

H. G. SOMMERFIELD, Ltd., 8, Camden Road, N.W.1.—Booklet dealing with shotblast and shells.

THE SUPERHEATER COMPANY, Ltd., 53, Haymarket, S.W.1.—Publication on power plant superheaters.

METAL PROCESSES, Ltd., 48, Frederick Street, Birmingham, 1.—Booklet entitled "Modern Finishes."

MORRISON, MARSHALL AND HILL, 44/45, Tower Hill, E.C.3.—Catalogue describing "Rushworth" plate bending rolls.

STEWARTS AND LLOYDS, Ltd., Brook House, Upper Brook Street, W.1.—Brochure on new standards for gas list steel tubes.

E. H. JONES (MACHINE TOOLS), Ltd., Edgware Road, The Hyde, N.W.9.—Catalogue on "Lunzer" high production rotating centres.

Personal and Business

MR. E. ADCOCK has been appointed secretary of E. H. Jones (Machine Tools), Ltd.

MR. R. F. HANKS and Mr. S. V. Smith have been appointed directors of Morris Motors, Ltd.

MR. J. WATSON NAPIER, M.I. Mech. E., M.I. Chem. E., has been appointed a director of Fisons, Ltd.

MR. A. YOUNG, Mr. R. L. Hunter and Mr. G. S. Steven have been appointed directors of Allied Ironfounders, Ltd.

EUCO TOOLS, Ltd., announces that it has moved to larger works at Fairfield North, Kingston-on-Thames. Its office address is 44, London Road, Kingston-on-Thames.

MR. F. W. HIGGINS has been appointed managing director of the Carborundum Company, Ltd., in succession to Mr. A. D. Kysor, who has retired after holding the office for eighteen years.

MR. LESLIE GAMAGE, vice-chairman and joint managing director of the General Electric Company, Ltd., has been appointed Chief Business Adviser to Lord Nathan, Minister of Civil Aviation.

THE LONDON, MIDLAND AND SCOTTISH RAILWAY COMPANY announces the following appointments:—Mr. C. J. Chaplin, district engineer, Bradford; Mr. G. D. S. Alley, district engineer, Derby (South); and Mr. J. Cunningham, district engineer, Abergavenny.

ALFRED HERBERT, Ltd., announces a new association of interests with the Fellows Gear Shaper Company of America, and the Gear Grinding Company, Ltd., of Birmingham. The new arrangement provides that Alfred Herbert, Ltd., who is agent for the Fellows Company's products, will act also as sole agent in the United Kingdom for the sale of the Orcutt range of spur and helical gear grinding machines, spline grinding machines and measuring and testing equipment made by the Gear Grinding Company, Ltd. By a reciprocal arrangement the Gear Grinding Company, Ltd., has undertaken to manufacture Fellows products, including Fellows gear shaper cutters, in this country, whilst the Fellows Gear Shaper Company will make "Orcutt" machines in America.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s. d.
F.I.A.T.:		
202	Manufacture of Plywood and Related Products in Western Germany	8 9
257	Summary Report on Food and Agriculture Targets	1 1
619	Waldhof Process for Production of Food Yeast	1 1
646	Polyamide Films Manufactured by Kalle and Co. A.G., Wiesbaden	1 2
820	Degussa Sodium Production Using Downs Cells	2 1
F.I.O.A.:		
51	Developments in the German Preserves Industry during World War II	2 1
EVALUATION REPORTS (post free 3d.)—		
B.I.O.S.:		
E/R 9	Saake Oil Burner and Turbines: Wagner Hochdrucken Dampfturbinen K.G.: Boilers	
E/R 429	(*a*) Weissensee Guss G.m.b.H.; (*b*) Spritzgusswerk "Fusor" (Subsidiary of Wintershall A.G.); (*c*) Loewe Werkzeugmaschinen A.G.; (*d*) R. Stock and Co. A.G., Abt. Werk Spritzguss: Die Castings	
E/R 430	(*a*) Reichstelle fuer Eisen und Metalle; (*b*) Huettenwerke Tempelhof G.m.b.H.: Metallurgy	
E/R 437	Metallisator Berlin A.G.: Spraying Pistols	
E/R 469	(*a*) Herzog Julius Hutte; (*b*) Norddeutsche Affinerie: Production of Pure Antimony	
E/R 473	Institut fuer Farbentechnik: Pigments, Metallurgy	
E/R 475	(*a*) Firma S. Siegle and Co.; (*b*) Firma G. Habich u. Soehne: Pigments, Metallurgy	
C.I.O.S.:		
XXXIII–50	Synthetic Fibre Developments in Germany (in four volumes)	55 8
XXVII–99	The Manufacture of Homogeneous Light Armour	1 8
XXXII–26	Plastics in German Aircraft Tooling	2 8
B.I.O.S.:		
283 (Appendix)	Precision Machine Tools and Gauges (Appendix): The National Physical Laboratory Report on Samples of Four Types of Measuring Apparatus of German Manufacture	1 1
532	Visit to Chemical Research Establishments Working on Combustion Problems	6 2
584	Investigation of the German Oil Engine Industry: Design, Research and Production	45 7
799	German Umbrella Cloth Industry: Weaving, Yarn Dyeing, Waterproofing and Finishing	2 8
878	The Activities of the Commission for Boiler Protection and Feed-Water Treatment (KKS) for the Chief Commanding Officer of the Admiralty: Compiled by Korv. Kpt. (Ing.) Dr. Res. Dipl. Ing. C. F. Franzen	11 9
889	Manufacture of Nitric Acid, Ammonium Nitrate and Fertilisers at Bitterfeld, Wolfen and Piesteritz	5 2
894	Mineral Wool Plant: Gelsenkirchener Eisenwerk	0 7
895	Aluminium Production at Vereinigte Aluminiumwerke (V.A.W.), Luenen	0 7
897	Ferro-Alloy Production Furnaces at Elektrowerk Weisweiler	0 7
904	Aluminium Hydrate and Alumina Production in Italian Factories	1 8
909	Investigation Concerning Research and Development for and Manufacture of D.K.W. Cars in Germany	1 1
947	A General Investigation of the Sewing Thread Industry in Germany, including Machinery, Processes and Production Methods	2 8
F.I.A.T.:		
82	Summary Report on German Research and Technology in Food	1 1
125	Schoko-Buck, Stuttgart: Chocolate Production	1 1
829	Non-Ferrous Metal Production Processes in the Hamburg District	2 8
862	Poly-Vinyl Chloride Production at Burghausen and Ludwigshafen	2 8
EVALUATION REPORTS (3d. post free)—		
B.I.O.S.:		
E/R 192	Statliche Technicum (Fachschule) fuer Textil Industrie (State Technical School for Textile Industry) and Deutscher Forschungs Institut fuer Textil Industrie (Textile School and Testing Institute)	
E/R 208	Polmar Maschinen Fabrik: Woodworking Machinery	
E/R 210	H. Rottmann Sohne: Plywood Production and Machinery	
E/R 214	Deutsche Edelstahl Werke, Krefeld: Tubes for Ball Bearings	
E/R 236	I.G. Farben Industrie: Production of Barium Sulphide and Barium Sulphate	
E/R 265	Losenhausenwerk, Dusseldorfer Maschinenbau A.G.: Testing Machines	
E/R 281	I.G. Farbenindustrie: Synthetic Materials	
Classified List No. 2 of Industrialists' Reports on Germany (reports published up to and including October 26, 1946)		0 8
Technical Index of Reports on German Industry (reports published up to and including July 27, 1946)		5 3
Addenda and Amendments to the following reports have been issued and are available at the Sales Offices of His Majesty's Stationery Office:—B.I.O.S., Final Report Nos. 116, 122, 135, 199, 237, 260, 274, 289, 297, 299, 338 and 649.		
B.I.O.S.:		
Misc. 4	Testing of Dyestuffs, Textile Finishes and Other Chemicals for Toxicological Effects by I.G. Farbenindustrie A.G.	0 7
EVALUATION REPORTS (post free 3d.)—		
C.I.O.S.:		
E/R 217	Report of Manufacture of Air Photography Apparatus, &c., by Certain Firms in Germany (Munich and Stuttgart Area)	
B.I.O.S.:		
E/R 10	"Deutsche Bohrmeisterschule" (The German Drillers' School): Oil Drilling	
E/R 12	Interrogation of Dr. (Eng.) Oestrich: Aero-Engine Inspection	
E/R 266	Visit to Rhenania Phosphate Works and Five Potash Plants	
E/R 516	Demag Wetter: Production of Sintered Iron Bearings	
C.I.O.S., XXXIII–50: An Addendum to this report has been issued and is available at the Sales Offices of His Majesty's Stationery Office.		
B.I.O.S.:		
861	The Stratton Mission to Germany, July, 1945, on Hides, Skins, Leather, Footwear, Leather Substitutes and Ancillary Machinery	38 2
1006	Fellmongering Practice in Germany and Mazamet (France)	6 2
1076	Cast Tungsten Carbide and the Production of a Tungsten-Free Hard Metal	6 8
1085	German Production of Sporting Guns, including Shot Guns, Air Guns, Air Pistols and Small-Bore Rifles, also of Agate Rings for Fishing Rods and Fish Hooks	1 7
1086	Report on German Manufacture of Fish Hooks and Agate Rings for Fishing Rods	1 1
1089	Aluminium Refining and Scrap Recovery at V.A.W. Erftwerk, Gravenbroich	5 2
1095	Developments in Methods and Materials for the Control of Plant Pests and Diseases in Germany	4 2
1137	German Vegetable Parchment Industry	4 2
1181	German Carbon Industry	9 3
1214	German Ferrous Wire Industry	10 9
1216	Tinplate Manufacture in Western Germany	8 3
1232	Embsen Nitric Acid Factory	2 8
F.I.A.T.:		
370	The German Abrasive Industry	5 8
446	Plastic and Wood for Aircraft Tooling and Fabrication	3 2
634	Coal Preparation Practice in Western Germany	10 9
725	High-Pressure, High-Temperature Process Heating 250 atm. (High-Pressure, High-Temperature Heating, 250 atm.)	1 1
781	The Leitz "Xenon" F 1: 1·55cm Lens	1 1
814	German Production of Some of the More Important Inorganic Pigments	7 2
847	Butadiene Catalysts	0 7
856	Manufacture of Polyvinylethers	1 7
877	Selection and Application of Mold and Core Blackwashes	1 7

B.I.O.S. Information Section, 37, Bryanston Square, W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

The British Transport Commission

FOLLOWING the passing of the Transport Act, 1947, the Minister of Transport has announced that invitations to become full-time members of the British Transport Commission have been accepted by Sir Cyril Hurcomb, Lord Ashfield, Mr. John Benstead, Lord Rusholme and Sir William Wood. The Minister hopes to announce shortly the appointment of a part-time member from Scotland. Sir Cyril Hurcomb, who will serve as Chairman of the Commission, acted as Director-General of the Ministry of War Transport during the war, and has been Secretary to the Ministry of Transport since 1946; he is also Chairman of the Electricity Commission. Lord Ashfield has been Chairman of the London Passenger Transport Board since its formation in 1933, and was formerly chairman and managing director of the Underground Group of Companies; Mr. John Benstead is the General Secretary of the National Union of Railwaymen; Lord Rusholme is the general secretary of the Co-operative Union, Ltd.; and Sir William Wood, who entered the service of the Midland Railway in 1898, is the president of the London, Midland and Scottish Railway Company. The Minister of Transport has also announced during this week the membership of the Transport Arbitration Tribunal established by Section 105 of the Transport Act. Mr. C. Montgomery White, K.C., is to be President of the Tribunal for proceedings other than Scottish proceedings, for which Mr. C. W. G. Guest, K.C., will act as President; the other members are Mr. B. G. Catterns and Sir Russell Kettle.

Diesel-Electric Locomotives for the L.N.E.R.

THE board of the London and North-Eastern Railway Company has approved plans for the construction of twenty-five diesel-electric locomotives of 1600 h.p., which are to be used for hauling the principal Anglo-Scottish expresses. The L.N.E.R. says that, although the scheme has not yet been worked out in detail it envisages the operation by diesel-electric locomotives of about thirty weekday and Sunday expresses over the East Coast main line between King's Cross and Edinburgh, and it is possible that the locomotives may be worked as far north as Aberdeen. Altogether, with additional trips between places like King's Cross and Grantham and Doncaster, it is likely that about 2,500,000 train miles will be covered annually by diesel-electric locomotives. The diesel-electric units, which will work in pairs to form 3200 h.p. locomotives, operated by multiple-unit control, will between them probably possess twenty-four wheels—sixteen of them drivers—will weigh about 240 tons and measure approximately 114ft over buffers. The present "Pacific" steam locomotives have a starting tractive effort of 37,000 lb, but the double diesel-electric locomotives will, it is estimated, muster a starting tractive effort of 90,000 lb and will be capable of running at a speed of 100 m.p.h. The scheme takes into account also the special maintenance and servicing arrangements which will be necessary, and it is likely that the main depot for the diesel-electric locomotives will be situated near Edinburgh with a subsidiary depot as near as possible to King's Cross.

Opencast Coal Production

REPLYING to a question in Parliament on Thursday of last week, the Minister of Fuel and Power stated that, in view of the imperative need for a higher output of coal, the Government had decided to extend the present programme of opencast coal working, which was timed to expire at the end of 1949, until 1951. It was hoped that contractors would thereby be enabled to plan the large extension of their operations which would be needed if output of opencast coal was to be raised above the present level of 9,000,000 to 10,000,000 tons a year, and also to purchase and bring into use the considerable amount of excavating machinery which had been ordered in the U.S.A. for delivery during the next year or so. The Minister said that the Government recognised that it would be impossible to shut down opencast working suddenly at the end of 1951, when production would be running at a high rate, and operations would therefore be continued on a gradually diminishing scale for the following few years. It was hoped that with the removal of uncertainty regarding future prospects, all those concerned with opencast coal would make a determined effort to secure a largely increased rate of production and to sustain it at a high level over the next few years. It is of interest to note that since 1942, when opencast working was begun in this country, over 36,000,000 tons of coal have been produced. The present output is 210,000 tons a week, a figure which, it is hoped, will be increased to 250,000 tons a week. Opencast working is carried on in all the coalfields except Somerset and Kent, and there are about 130 sites in operation at any given time, a number which, it is stated, will be increased as plant becomes available. Land requisitioned comprises about 32,000 acres, of which less than 1000 acres are woodlands. In all, about 10,000 men are employed on opencast working and the output per wage earner is reckoned to be about four times as great as for deep mines.

L.N.E.R. Train Collision at Doncaster

A COLLISION between two express trains occurred last Saturday afternoon about half a mile south of Doncaster Station on the London and North-Eastern Railway. The trains involved were the 1.10 p.m. and the 1.25 p.m. expresses from King's Cross to Leeds and Bradford, the first of which was stationary near the Balby Junction signal-box. The following train crashed into the rear of it, the locomotive overturning some yards beyond the point of impact. The first three coaches of this train were derailed and the last four coaches of the stationary train were smashed, while yet another coach was derailed. Both trains were crowded with holiday travellers and most of the casualties occurred in the closely packed rear coaches of the stationary train. We regret to record that, as a result of the disaster, eighteen persons were killed and over seventy were injured. Both the up and down main lines were cleared of the wreckage by Sunday afternoon, when it was possible to resume normal working. The Ministry of Transport inquiry into the cause of the disaster was opened yesterday, Thursday, morning at Liverpool Street Station by Lieut.-Colonel Sir Alan Mount, Chief Inspecting Officer of Railways.

Standardisation of Low Voltage Supply

A CIRCULAR letter, dated August 11th and addressed by the Electricity Commission to all authorised undertakers, states that the standard system for the supply of energy at low and medium voltages as approved by the Commissioners on September 21, 1946, will become mandatory after October 1, 1947, in respect of new electrical systems brought into use after that date, unless some other system of supply is specifically approved by the Commissioners. It is stated that there is no intention at present of making the new standard system mandatory for existing non-standard systems. Nevertheless, discussions have been held with the Electricity Supply Joint Committee about the conditions that could reasonably be applied in instances where undertakers change over from a non-standard voltage to the new standard. Agreement has now been reached on this matter and it is stated that, although the conditions of agreement were drawn up to deal only with a change of a.c. voltage they are equally suitable with the necessary adaptation for a change of system from d.c. to a.c. The Commissioners recognise that shortage of labour and material is likely to delay any extensive change-over and that the shortage of plant makes it generally undesirable at present to raise the voltage of 230-V systems to 240V owing to the resultant additional demand. Except in cases of change from 250V or 230V to the new standard, however, much preliminary investigation is required before any labour and materials would be used and the Commissioners are prepared to give their consent to a change of system or voltage, subject to conditions appended to their letter, in the case of any undertaker who is ready to proceed with the necessary preliminary work and who wants to be able to put the work in hand as soon as circumstances permit.

The Iron and Steel Industry

DURING the committee stage of the Supplies and Services (Transitional Powers) Bill, which occupied the House of Commons throughout the night of Monday last, the Lord President of the Council, Mr. Herbert Morrison, made some reference to the iron and steel industry. An amendment was moved by Major P. Roberts that a clause should be inserted in the Bill providing that the powers to be taken by the Government to deal with the economic situation should not include the bringing of all or any part of the assets of the iron and steel industry under public ownership. Mr. Morrison explained that under existing Regulations, the competent authority—which included the Minister of Supply—could be enabled to provide by order for the transfer to the Minister or competent authority of the shares of any company placed under control of the authorised controller. These powers were preserved by the Act of 1945, and if it was expedient and desirable in the public interest to use them in relation to particular undertakings in the iron and steel industry, the Government would use them. Mr. Morrison assured the Committee, however, that the Regulations would not be used for the purpose of socialising the whole industry. Defence Regulations, he said, should not be used for the socialisation of whole industries, and if an industry had been nationalised it had been done by Act of Parliament. The Government would continue to use that procedure.

British Railway Accidents in 1946

THE annual report for 1946 of the Chief Inspecting Officer of Railways, Lieut.-Colonel Sir Alan Mount, was published at the end of last week (H.M. Stationery Office, price 9d.), and records that train accidents during the year resulted in the deaths of thirty-four passengers and nine railway servants. Of the passenger fatalities, twenty occurred at Lichfield, ten at Browney, Co. Durham, two at Potters Bar, one at Catford, London, and one at Stafford. The report also shows that the fatality rate amongst passengers was one in nearly 1000 million miles of travel, and that of the 1237 train accidents of all kinds during the year, human failure accounted for 526 and defective rolling stock, track or apparatus for 180. In movement accidents, other than train accidents, eighty-six passengers were killed during 1946, compared with an average of 111 for the period 1940–45, and, in addition, 227 railway servants were killed. Fatalities in 1946 in all movement on rail, including train accidents, totalled 413, a figure lower than in any of the six preceding years and nearly 23 per cent below the 1941 peak of 534. On the other hand, the report points out that the figure was still considerably higher than the pre-war average of 338 for the years 1935–39. In general, the report states, the year 1946 was a difficult and disappointing one for the railways. Little, if any, headway was made in overtaking arrears of maintenance, and it was broadly a case of continuing the policy of "make do and mend." Recovery was impeded by shortages of materials and labour. Examples affecting speed and safety of operation were that, by the end of the year, arrears of renewals of rails in running lines increased to about 400,000 tons and of sleepers to about 10,000,000.

Lighthouse Engineering

By K. C. SUTTON-JONES, Stud. Inst. C.E.

No. VI—(*Continued from page 119, August 8th*)

IT has been seen from the first five articles in this series that the tendency in lighthouse practice is towards semi and fully unattended operation. The acetylene and battery systems are complete in this respect, and the advent of modern electrical principles has also brought about many automatic features which, when applied together, are capable of rendering the lighthouse or lightvessel entirely automatic in operation.

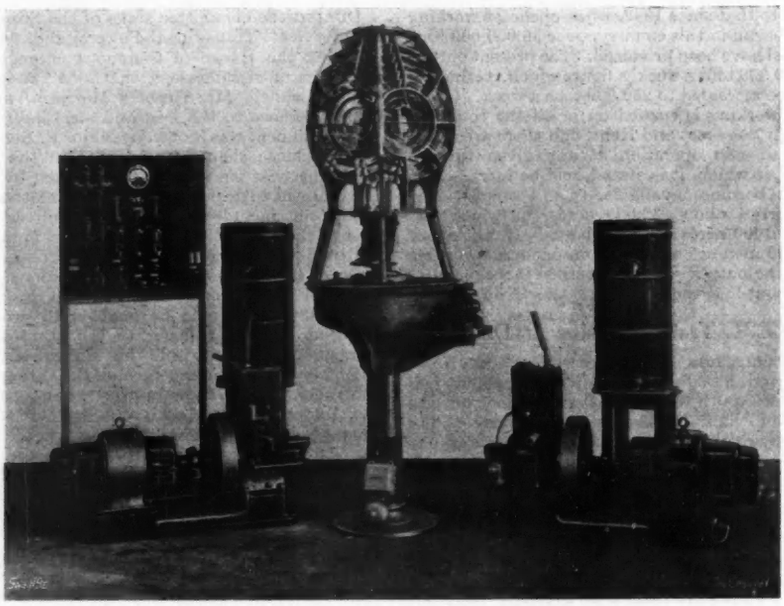


FIG. 23—FOURTH ORDER ELECTRIC LIGHTHOUSE INSTALLATION

Switching the plant on and off may be left entirely to the operation of the "A G A" sun valve, the "Chance" light valve, the photo-electric switch or the solar time switch, whilst failure of the lightsource is amply safeguarded by such devices as the automatic gas mantle changer or by one of the many types of lampchanger. Automatic rewinding motors for the clockwork mechanism or duplicate or triplicate systems of optic drive ensure continuity of revolution of the optical apparatus and electric supply with automatic standby equipment may be provided. The latter comprise generator sets in duplicate or triplicate, operating either directly to load or through a battery.

Bearing all these features in mind, we now examine the application of them in practice.

AUTOMATIC CONTROL

Fig. 23 shows a complete automatic lighthouse plant by Chance Brothers, comprising optical apparatus, switchboard and duplicate generating sets—installed in Australia. This particular optical apparatus is designed to give quadruple flashing every 20 sec., the duration of flash being 0·23 sec., with short eclipses of 2·44 sec., and a long eclipse between the groups of 11·76 sec. The effective beam intensity is 608,000 candles, giving a luminous range in clear weather of approximately 36 sea-miles.

The optical apparatus is mounted upon a mercury-float type pedestal, and rotated by means of a fractional h.p. electric motor and reduction gear, which drives through a friction disc, a pinion meshing with the race wheel. A standard lampchanger, equipped with two 500-W bunch filament lamps, is installed in the apparatus, their focusing being effected through the medium of a focusing telescope fitted to the optical framework.

Current is provided for the lamp by duplicate automatic generating plant consisting of two 1-kW generating sets each mounted on a separate baseplate, and arranged so that in the event of failure of the working set the stationary set immediately starts automatically and supplies the lamp. The system is such that each set will operate alternately—neither running on two consecutive nights, the object being to keep each set in good working order. The engines are 2 h.p. stationary petrol engines, running at 1000 r.p.m., each being fitted with a magnetically-operated petrol valve, which has a safety device for automatically closing the petrol supply to the carburettor when the engine stops, and thus obviating flooding of the carburettor.

The generators are of the enclosed, ventilated, continuously rated compound wound type, each producing 9·1A at 110V when driven at a speed of 1000 r.p.m. Each generator is double-wound, the armature being provided with a commutator at each end. One of the windings is arranged to start the engine from a 12-V battery, whilst the higher voltage winding is for use as a generator. When generating, the shunt winding used at starting comes into operation as a compound winding, and with the two armatures connected in series, the output is as stated above. In addition, the 12-V starting battery is charged at 2A when in parallel with a resistance across the low-voltage armature.

An electric bell is provided to give audible warning of failure of either of the two sets or of a lamp.

In New Zealand, a number of former oil-burning lighthouses have been electrified and radio beacons installed as an additional aid to shipping.

The illuminant, now installed in the original optical equipments, is the 1000-W gas-filled electric filament lamp. These are supported within the optical apparatus in duplicate, upon a lampchanger which brings a standby lamp into focus automatically upon main lamp failure. The optical apparatus is rotated by a fractional h.p. electric motor through a worm reduction drive—being coupled by a spring-loaded clutch to safeguard over-run due to stopping momentum, and to alleviate inertia strain during starting. The original lens clock and kerosene lamp are held in readiness for bringing into operation manually upon electric supply or motor failure. The automatic switching on and off of the equipment is effected by means of a "Venner" time switch. It is not to be assumed, however, that the lights are left unattended—the automatic features simply reduce the number of attendants required. Furthermore, the inclusion of automatic features renders it unnecessary to have the attendants' dwellings actually at the foot of the light tower—indeed, in one instance in New Zealand, the power house is some 600 yards from the attendants' dwellings.

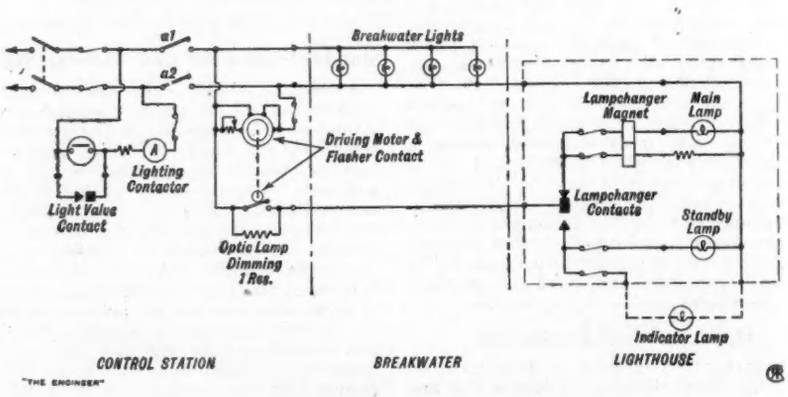


FIG. 24—UNATTENDED BREAKWATER INSTALLATIONS

The electric power equipment at each lightstation comprises two 18 h.p. Lister diesel engines coupled to 9-kW 110-V d.c. generators. The engines are provided with protective devices for stopping the one set

and starting the reserve set upon oil pressure failure or excessive cooling water temperature. Power for cranking the engines is derived from a main battery (of 250-Ah capacity) of nickel-iron construction, having a charging rate of 63A. The engines and generators can be operated manually by start and stop push buttons on the switchboard, but are normally under the control of the time switch—running alternately as battery-charging sets when the state of battery charge falls to a certain level. The load, comprising lamp, optic revolving motors, radio beacon, &c., is drawn from the battery, which is maintained in a charged condition by means of an Austinlite automatic battery regulator, which starts and stops the engine generator sets as required and which also switches the end cells so as to maintain a narrow tolerance on voltage despite variations in load. The sets may be run direct to load at will and, in order to maintain constant voltage under such conditions, a vibratory type automatic voltage regulator of Isenthal manufacture is fitted to each engine bedplate.

All switch and control gear is housed within a sheet steel cabinet and the entire apparatus is remarkably robust, although of neat appearance.

The alarm system at these lighthouses is typical of modern practice and is as follows: Failure flag indicators are fitted which indicate engine failure and source of failure —optic motor failure, main lamp failure, &c. In the event of a fault developing and the alarm ringing continuously, the attendant is awakened from his sleep and a glance out of the window shows the light to be rotating and burning normally. This immediately eliminates two sources of failure —a drop in voltage or a failure of the lens-rotating motor. The fault, must, therefore, be in the power house, and must be investigated. The flag up at either of the two engine fault indicators would reveal the cause. The attendant can immediately stop the alarm ringing by resetting the push button on the alarm relay and can discover and rectify the fault. If a drop or a rise in voltage has been the cause of the alarm ringing he would have noticed it instantly when he switched on the light. Thus, it will be seen that even with a number of fault indicators, all capable of ringing the alarm continuously, it is quite a simple matter to ascertain the one responsible. A further indicator serves a double purpose. Its energising coil is in series with the main lamp circuit, and it rings the alarm for about twenty-five seconds should one lamp burn out and be replaced under the action of the lampchanger. This coil also tinkles the alarm bell when the apparatus is automatically switched on at night, thereby indicating to the attendant that the lighthouse has commenced operating.

Although erected as long ago as 1910, the Platte Fougère Lighthouse, off Guernsey, is particularly interesting as an example of remote control. Devised by Messrs. D. and C. Stevenson, of the famous Scottish family of lighthouse engineers, the tower was built to a height of some 80ft, and of irregular octagonal form. A complete acetylene gas plant mounted at the top of the tower was devised to feed the light and the valve is actuated automatically by clock-work mechanism. A fog siren is also installed in the tower, complete with compressor plant. This latter is started electrically from the shore by means of a submarine cable and a complete alarm system is employed.

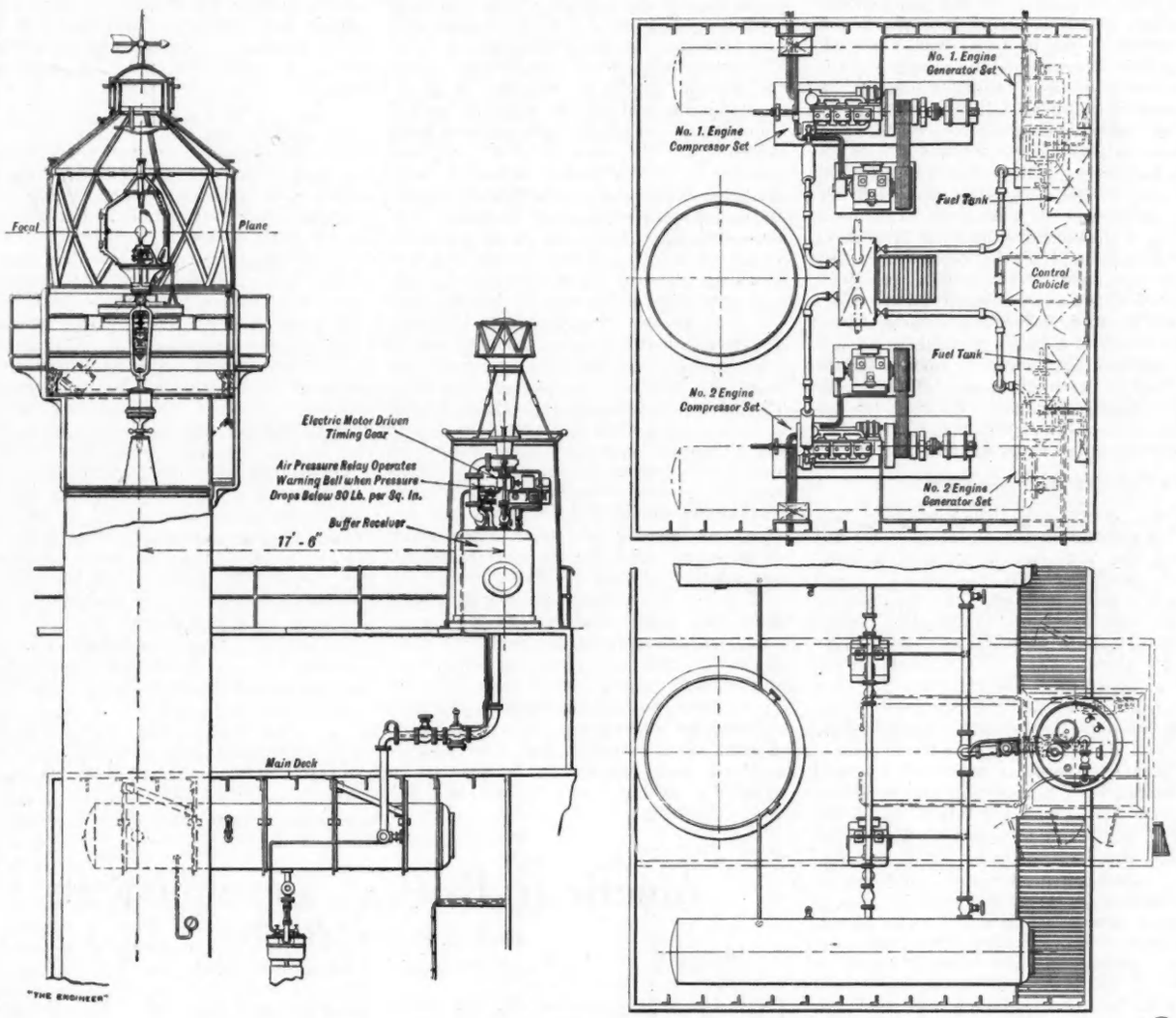

Focal Plane
Electric Motor Driven Timing Gear
Air Pressure Relay Operates Warning Bell when Pressure Drops Below 80 Lb. per Sq. In.
Buffer Receiver
17' - 6"
Main Deck
"THE ENGINEER"
No. 1. Engine Generator Set
No. 1. Engine Compressor Set
Fuel Tank
Control Cubicle
Fuel Tank
No. 2 Engine Compressor Set
No. 2 Engine Generator Set

FIG. 25—ELECTRIFICATION OF BAR LIGHTVESSEL

In Fig. 24 will be seen a diagram of a typical unattended breakwater installation by Chance Brothers, for operating off mains supply. The load not only consists of the lighthouse lamp and control gear but also the provision of lighting along the breakwater, all operative by the same means of control. Referring in detail to the diagram the sequence of operation is as follows:—Upon dusk falling the light valve closes the circuit to relay "A," which has two normally open contacts, *a*1 and *a*2, which close, thus completing the

mains and breakwater lamp circuit and also the flashing mechanism circuit. This latter comprises a small electric motor which drives a cam, tilting a mercury switch at preset intervals. This "nigresces" or "flashes" the lamp within the lighthouse, thus giving the required character (the lens being of the "fixed" type).

A lampchanger is fitted within the lighthouse, supporting two lamps, and upon failure of the main lamp the latch is released and the second lamp is automatically brought into focus and kindled. An indicator lamp is provided for giving warning shorewards upon such a lamp change-over taking place. The trip mechanism of the lampchanger comprises two coils acting in opposition to one another—one in series with the main lamp—the other across the supply. Thus, upon the main lamp failing, the series coil becomes de-energised, thus permitting the voltage coil to close the relay, which action operates a trip mechanism and allows the lampchanger to assume the standby lamp position. In the apparatus typified in the diagram it will be noted that the major portion of the control equipment is arranged at the shore end of the breakwater, thus permitting easy access. This particular installation caters for lamp failure only, but mains supply failure is often safeguarded by provision of a battery, which is brought into operation automatically upon a failure. The battery is then charged off the mains supply during daylight. In such circumstances it is customary to provide sufficient battery capacity for two winter nights.

The Mersey Bar Lightvessel

Whilst many new lightvessels are now under construction for replacing those lost during the war—one very notable lightvessel (see Fig. 25) has recently been electrified and refitted for the Mersey Docks and Harbour Board by Chance Brothers. This is the Mersey "Bar" lightvessel "Alarm"—the locating point for the Port of Liverpool. The apparatus installed some thirty years ago consisted of a petroleum vapour burner and triple-flashing small third order optic mounted upon a pendulum—the whole of which was revolved by clockwork. The optic is in good condition and has been mounted upon the latest type of pendulum apparatus, which incorporates the electric revolving motor and reduction gear within the bow. Illumination is provided by a 1000-W, 50-V electric filament lamp, and since this lightvessel experiences heavy rolling and pitching, special divergence is required which is provided by a special diverging screen mounted between the lamp and the lens. The pendulum apparatus is supported on gymbals within the existing lantern and tower—the latter being of the plated type and situated amidships. Means for the hand-turning of the optical apparatus is provided for use in an extreme emergency.

Fog signalling had been provided hitherto by a compressed air siren, which is now replaced by a "G" size diaphone, which consumes approximately 23 cubic feet of free air per second of blast. The instrument has a range of at least four miles. This instrument, together with electrically-driven timing mechanism, sounding valves and low pressure air receiver, is housed within a steel cabin elevated above deck, which is itself surmounted by a vertical resonator having a "mushroom" head for directing the sound into the horizontal plane. In this manner the "mouth" of the resonator is elevated considerably, to the good effect of the signal. The cabin is large enough to accommodate an attendant for servicing purposes.

Although the diaphone instrument operates off a pressure of 35 lb per square inch, the air is stored at 100 lb per square inch pressure. This enables the diaphone to be put into commission immediately when fog settles, there being sufficient air and pressure available to allow for plant starting. Air passes from the high to the low pressure receiver via a stop valve and a reducing valve. The driving and sounding valves are operated off the air main via independent small bore piping.

The air compressor plant is in duplicate so as to provide a standby, but air may be drawn off either or both main high pressure receivers for operating the diaphone. The air compressors are diesel engine-driven and do not commence delivery of air to the receivers until the full speed is reached. Upon 100 lb per square inch pressure being exceeded in the main receiver, the compressor is automatically unloaded until the pressure falls to a preset figure, whereupon the compressor resumes delivery of air. Pressure gauges and safety valves are fitted to the high pressure receivers. The engines and compressors are interconnected by "Brammer" belting, and the engines are started by push button control—the buttons being mounted on the sets themselves. Starting torque is provided by Bendix type starters operating off independent batteries. Coupled also to each engine shaft is an 80-V generator, which supplies current to the submarine oscillator equipment—sounded in foggy weather. Special relays fitted to each engine give alarm should failure of oil pressure or excess cooling of water temperature occur—upon which the set is stopped automatically.

Electric current for supplying the main lamp, optic motor, diaphone, timing mechanism, radio beacon, domestic lighting, refrigerator, half-mile signalling lamp and control and alarm circuits is provided by a main battery, comprising 27 cells of 1400-Ah capacity. The battery is charged automatically by two engine generator sets, which can be selected as required according to the demand—a standby set always being available. The battery-charging switchgear is devised so as to maintain the battery in a charged condition automatically. The engines are started electrically, but the starting torque is provided by special windings on the generator, which are fed off the main battery. Additional alarms are provided to safeguard against generator overload and reverse current—the engine being stopped automatically in either case. Visual and audible alarms are also arranged for denoting state of battery charge, state of air pressure in the main receivers, and failure of the optic lamp.

All controls (with the exception of the compressor starting controls), indicating instruments, switchgear, alarm indicators, &c., are contained within a mild steel cubicle in the engine room.

Conclusion

In this series of articles many types of equipment have been examined, together with many differing systems of operation; yet each has its function in the wide field of navigational aids.

The transitional period between war and peace is a difficult period for speculation as to the changes likely to be forthcoming. The war has produced many wonderful developments, especially in the radio field, and views among experts seem to advise us that radio aids will be supplementary to existing methods. Certainly radio developments could not supersede existing methods until every vessel (large and small) is equipped suitably. In this connection psychology comes into the picture in that it is not tolerable to shut oneself in and see a picture painted electrically, when one can go out on deck and see the picture with one's own eyes. It is only when bad visibility impairs this direct vision that the electronic device is to be preferred.

Whatever changes may take place, the mariner can depend upon the wholehearted assistance of the engineer in providing reliable and suitable aids.

The automatic mantle changer illustrated in Fig. 7 on page 48 is by the Gas Accumulator Co., (U.K.), Ltd.

American Railway Developments

By E. E. RUSSELL TRATMAN

No. II (*Continued from page 130, August 8th*)

IN the preceding part of this article the supporting elements of the line have been considered, including the road bed or soil, the ballast, the ties or sleepers, and the tie-plates or base plates which protect the ties from mechanical wear by the rails. There are now to be considered the rails and their appurtenances and the labour element in the maintenance of the line.

Steel Rails

Long and detailed field, mill and laboratory study of the design, manufacture and service performance of steel rails of the T or flat-bottom type in universal use on American railways has resulted in the adoption of certain standard sections. But changes in service conditions have necessitated some modifications from time to time. In 1946 the American Railway Engineering Association approved revisions in the 112 lb and 131 lb sections, and their joints or splice bars. For the former there is now a 115 lb section, 6⅝in high and 5½in wide. A special feature was the including of two alternative sections of 132 lb and 133 lb per yard, in place of the original 131 lb section. This was due to the fact that several heavy traffic railways desire a rail with a deeper head. The three sections are listed in the accompanying table, and the typical 132 lb rail is shown in Fig. 4.

New American Rail Sections

Weight, lb per yard	115	132	133
Height, inches	6⅝	7⅛	7⅛
Base width, inches	5½	6	6
Head, per cent	34·8	34·1	36·3
Web, per cent	27·1	28·3	26·5
Base, per cent	38·1	37·6	37·2

Rail replacements are made principally for the following reasons:—(1) To obtain rail for relaying, which accounts for 65 per cent of the rails removed; (2) rails too badly worn or too light in weight for good riding at high speeds; (3) development of failures or flaws in rails; (4) end batter of rails; (5) head wear of rails on curves. Rails removed have an average age of 18½ years (12 to 26

years). Head wear is a minor factor, except on curves. Further study is to be made as to what tonnage of traffic would warrant use of heavier rails.

Welded rails are being used on many railways, using gas fusion, electric pressure, gas pressure, and thermit pressure processes. Lengths of welded rails range from 585ft to 12,782ft. A report on corrugated rails states that greater hardness of surface in the ridges of corrugations has been established, and it is now proposed to determine the conditions under which slippage of driving wheels

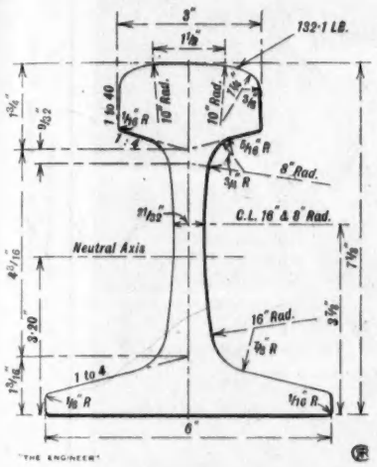


FIG. 4—NEW AMERICAN RAIL SECTION

occurs as a cause of corrugation. This slippage heats the steel to a quenching temperature, producing a very hard quenched martensite structure on the rail surface.

Other rail investigations in progress cover the following subjects:—(1) Engine burns on rails, caused by the spinning of driving wheels; (2) the effect of such burns on the structure of the steel; (3) the effectiveness of repairing such burns by electric or oxy-acetylene welding; (4) stress measurements in rails of 90 lb, 112 lb and 131 lb per yard; (5) fatigue in the webs of 112 lb rails. As to engine burns, it is considered that the martensite transformation creates quench cracks because of the volume change, and the cracks greatly reduce the fatigue resistance of the rail.

Rail Joints

Closely allied with the study of design and performance of rails is the study of rail joints—their design, manufacture, assembly, measurement of internal stresses and service performance. One phase of this study consists of laboratory rolling load tests on the value of lubrication of rail joints. These tests have indicated that wear of joints is but little affected by the mere flexing under passing wheel loads, but may be influenced considerably by the opening and closing of the rail gaps due to temperature changes in the rails.

From service experience and laboratory tests it is thought that corrosion is probably the major factor in causing wear of joints and the occurrence of "frozen" or "stuck" joints. As the fishing surfaces corrode, the rust is rubbed off by the flexing of the joint and the longitudinal slip of the rails in the joint. Constant repetition of this action accelerates the wear of the track. Lubrication is expected to minimise corrosion until the lubricant is worn or weathered away, so that it needs to be renewed periodically to avoid strong resistance to slip and resultant "frozen" joints.

In line tests of spring washers for rail-joint bolts it appears that of twelve designs nearly all were compressed solid in the joint and contributed little towards sustaining tension on the bolts. For perfect elastic action of joints in the line, a washer would be required that would go solid at an applied tension of 20,000 lb.

An annual report on continuous service and laboratory tests of various types of joint bars or fish plates includes records of wear, deflection, bolt tension and hardness of fishing surfaces, as well as cracks and other defects. Observations on the line indicate that the service life of joints with 36in bars is more than 1½ times that of joints with 24in bars, and that the former provide a smoother riding surface. Furthermore, the bars with short toe or outside bottom flange, as in Fig. 5, are in general giving performance equal or superior to that of earlier designs having a broad flange projecting beyond the base of the rail.

Rail Anchorage

Service tests are in progress to determine the efficiency of various appliances and methods for preventing longitudinal creeping of the rails. Such a test on one railway showed that in line carrying traffic in both directions the problem of anchoring the rails differs from that on line carrying traffic in only one direction. The rails should then be anchored to resist creeping in both directions. However, staggered anchoring seems undesirable, since it causes skewing or slewing of the cross ties on sleepers, and thus tends to distort the line and gauge of the line.

Switches and Crossings

Standard plans of switches and frogs, or points and crossings, have been adopted by the American Railway Engineering Association in co-operation with the Manganese Track Society. The 1947 report deals with stress measurements on cast manganese steel crossing frogs, or crossings at line intersections. The case noted is the intersection of two double-line heavy traffic railways, where measurements were recorded of stresses in various parts of the castings.

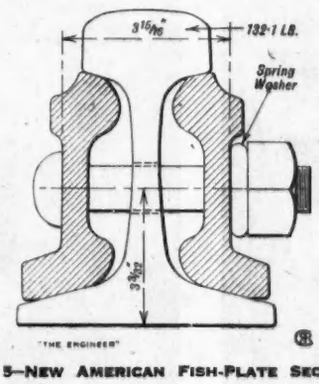


FIG. 5—NEW AMERICAN FISH-PLATE SECTIONS

Owing to the severe pounding and side thrusts at such line work, it is difficult to maintain the several lines in line and surface when they are supported on wood ties and long timbers. One experiment noted is the use of welded steel frames of T section as foundation for each crossing, the steel casting resting on the top flange and being secured to it by bolts and clamps. This construction has been found effective in lowering the stresses in the flangeways of the castings.

To test the effect of corrosion on the fatigue strength of cast manganese steel, since it is known materially to lower the fatigue strength of ordinary steel, some of the flangeways in the crossings were cleaned of rust and treated with special grease and wax. Periodical inspection will be made to determine whether such protection will help to prevent the formation of fatigue cracks.

Line Labour Economics

In addition to the various reports on the line and its characteristics, there is consideration of the problem of labour for carrying on the continuous maintenance and improvement work on the line. It has been noted already that the decrease in number of men available and the marked increase in the cost of the work have posed a new problem for the railway engineers, and one that calls for additional mechanisation of work on the line. Another phase of this increasing use of machines is the reduction in the use of work trains for handling men and materials for improvement work, since such trains inevitably cause interference with regular trains. Such slowing down or slacks are specially objectionable in fast and heavy traffic. This particular difficulty is being met by the use of "off-line" equipment, which is routed along the public roads.

At the 1947 convention reference was made to the preparation of a manual of instructions as to the care and operation of the various machines, and a report was made on the use of portable power conveyors for handling materials and for removing snow.

Conclusion

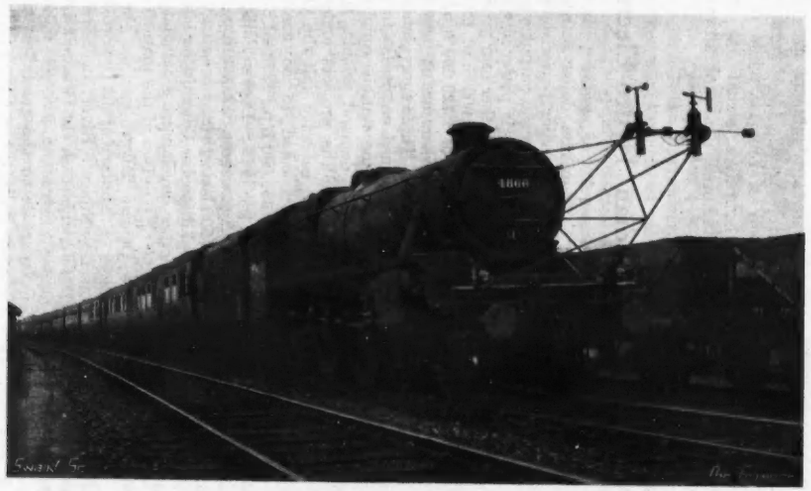
All this research work goes on continually under the direction of committees, so that the annual reports represent current activity and progress rather than final conclusions. And as certain subjects are disposed of, others are begun. Line work covers only one group of reports, while other groups deal with bridges, structures, stations, terminals, and other phases of railway operation.

Canadian Hydro-Electric Plan

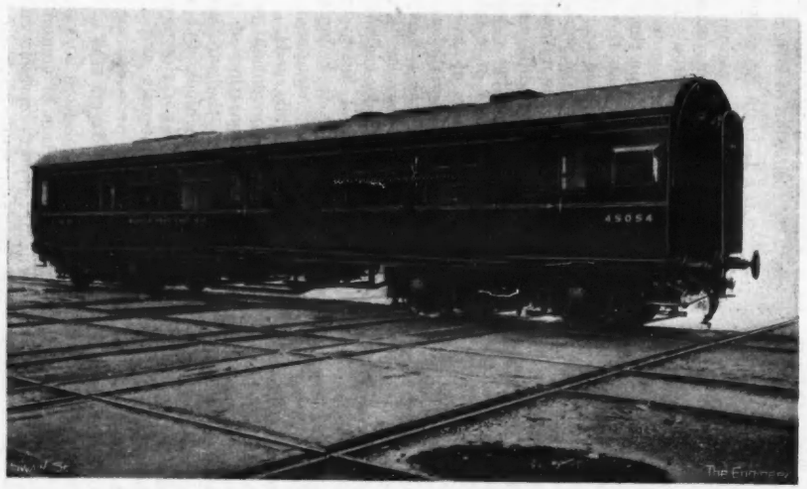
As a result of growing industrial demands, a 93 million dollar construction programme of five major power developments is planned to increase the output capacity of the Ontario hydro-electric power system to nearly 2,300,000 h.p. in another four years. The new plants will add 571,000 h.p. to the present normal capacity of 1,720,000 h.p. Some 4000 construction workers are at present employed on these jobs. These new plants will enable the publicly-owned enterprise to supply from its own generating stations roughly two-thirds of the total demand within the province. Following are the projects under way, their normal plant capacity and the year in which they are expected to be completed:—Des Joachims, 360,000 h.p., 1950–51; Stewartville, 81,000 h.p., 1948; Decew Falls, 70,000 h.p., 1947; Aguasabon, 53,000 h.p., 1948; Ear Falls, 7500 h.p., 1948.

In addition the Commission has under study four other developments calculated to produce 610,000 h.p. Two of the tentative sites are on the Ottawa River, one on the Madawaska River (a tributary of the Ottawa) and the other on the Nipigon River, in Northern Ontario. Des Joachims, on the Ottawa River, at present under construction, is to cost 55 million dollars. Comparable to the great Queenston plant at Niagara Falls, the work entails building a dam 2500ft long and the water impounded will form a lake 80 miles long and 1 mile wide. The first units are expected to be in operation in 1950, the others in 1951. Plans call for the addition later of two more units of 60,000 h.p. each, which will raise the ultimate normal plant capacity to 480,000 h.p.

L.M.S. MOBILE LOCOMOTIVE TESTING PLANT



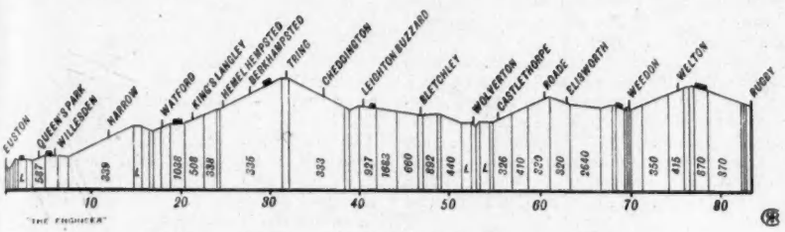
TEST TRAIN
CONTROL COMPARTMENT OF BRAKING UNIT



BRAKING UNIT
AUXILIARY ENGINE ROOM

L.M.S. Mobile Testing Plant

IT has been the custom for many years on the L.M.S. Railway to test locomotives by means of a dynamometer car interposed between engine and train, which records speed, tractive effort and units of work done on a moving chart. These tests have been carried out under ordinary running conditions on the line, in which the speed varies from point to point according to the natural variations of gradients and other forms of resistance. The results so obtained, usually epitomised as the coal and water consumed per drawbar horsepower hour, clearly only give a result which is an average of all the changing conditions experienced throughout the run. Rigidly accurate comparisons could not therefore be made, but results of sufficient practical accuracy for design policy purposes have been obtained provided the comparisons were made over the same route and with the same weight of train.



PROFILE OF SECTION OF LINE: EUSTON TO RUGBY

With the narrowing down of the economies to be obtained from further technical progress a more accurate means of locomotive testing on the line has become necessary and to this end means have to be found of working the test engine at a succession of constant speeds, each of which has to be held for an appreciable period of time. An inherent difficulty in this is the maintenance of reasonably constant conditions over a sufficient length of time to enable reliable observations to be recorded.

In certain countries, such as Germany, Poland and Russia, long stretches of practically level and straight track exist over which tests can be carried out under such conditions, using compression brakes or other means to ensure constant speed. In Great Britain, however, such facilities are difficult to obtain. On the L.M.S., for example, there is no suitable stretch of line for carrying out tests of this kind, the best section available being probably that between Euston and Rugby, but examination of the profile of this line, shown in the diagram reproduced, indicates how difficult it would be to maintain constant speed for any length of time, even by the use of braking locomotives.

Constant working conditions of a locomotive could be maintained on undulating track if the resistance of the train could be immediately adjusted to compensate for the effects of gradients, curves, &c., when the equivalent of straight and level track would be obtained. It was found on investigation that this result could be achieved by the use of electric locomotives with rheostatic braking, having a very sensitive form of control that would maintain an exactly constant speed irrespective of changes in the drawbar pull of the engine or the resistance of the track. A new test train, known as the "Mobile Testing Plant," was authorised in 1936, comprising a special tender, a dynamometer car and three braking units. Each of the braking units is, in effect, an electric locomotive designed for braking instead of pulling, and is capable of absorbing up to 1500 h.p. These three units are very similar in design except that they have different gear ratios for testing different classes of locomotive and have maximum speeds of 50 m.p.h., 90 m.p.h., and 120 m.p.h., respectively. They may be used singly or in any combination and will, together, give a maximum braking effort of 23 tons. The master controls for all three braking units are mounted in the dynamometer car, which thus serves both as an independent vehicle for controlling the braking units and to measure the speed and drawbar pull of the locomotive.

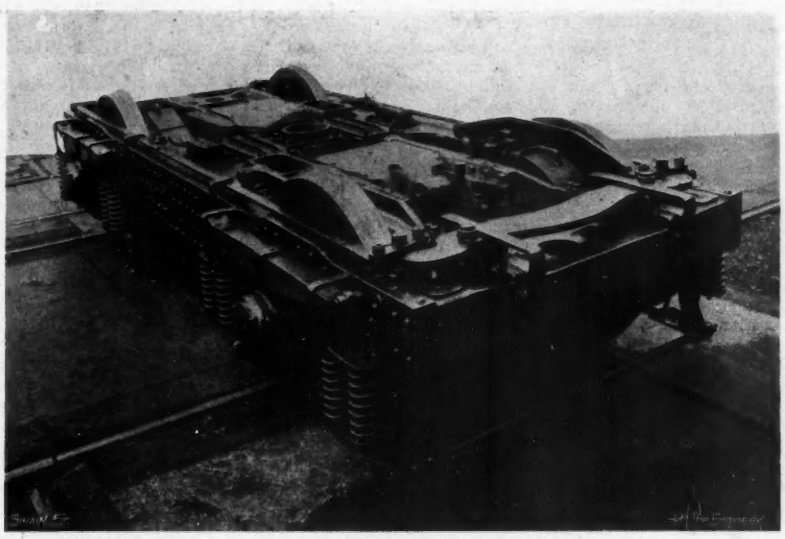
The three braking units, illustrations of which appear on these pages, were practically completed in 1939. They were used during the war as emergency power generators and are now being reconditioned. The tender and the dynamometer car are as yet uncompleted, but tests are already being carried out using the low speed unit and the company's No. 1 dynamometer car, which is being equipped with the master controls and other necessary apparatus.

The special tender, which can be attached to any locomotive of standard type, is intended for measuring the rates of consumption of coal and water during the test. Three tons of coal, previously weighed out into hundredweight bags, can be carried in a special compartment and brought forward as required. A further three tons of loose coal, for use at other times than the periods of test, can also be carried in a bunker of normal shape. The tank contains 3500 gallons of water and the feed from the tender to the locomotive is measured by a displacement type water meter. A corridor connects the front of the tender with the dynamometer car so that access may be obtained to the locomotive footplate during the run.

The new dynamometer car will have the form of a double bogie coach with a single additional unflanged road wheel mounted on the leading bogie for accurately measuring the speed of the train and the distance travelled. It will contain an Amsler hydraulic dynamometer coupled to the leading drawhook through a friction drawgear. The dynamometer is connected with a recording table which will give a continuous record of drawbar pull, speed, work done, &c., on a basis of either time or distance. The master controls of the three braking units are fitted in a desk panel and instruments are provided to indicate the loading of each of the units. Another panel will carry instruments, such as temperature indicators, &c., for studying the working of the locomotive while running.

The braking units are similar in construction to very powerful motor coaches, the "motors" being actually generators resisting the motion of the train. The power generated is absorbed by banks of resistance grids which are cooled by being mounted in vertical "chimneys" up which a current of air is forced by motor-driven fans. The energy of braking is thus finally dissipated in two columns of hot air expelled vertically through openings in the roof, the openings being protected by sliding covers when not in use. As the full power of the generators may be required at very slow speeds, they are separately blown by motor-driven centrifugal fans. The large amount of auxiliary power required for the resistance fans for the blowing and excitation of the generators, and for other purposes, has necessitated the provision of an auxiliary generating set comprising a 100 h.p. A.E.C. diesel engine and generators. The auxiliary generator is connected in parallel with a 120 amp. hour battery which provides standby power in an emergency and heating and lighting when the generating set is not running. Separate auxiliary generators driven from the same engine provide the excitation for the main generators and an alternating current supply; the auxiliary engine-room is arranged in the middle of each braking unit.

The bogies of the braking units are of the four-wheel pattern, each having two generators rated at 375 h.p. each. In the bogies of the low speed unit the generators have suspension bearings and are supported by the axles as in a normal motor coach. In view of the weight of these generators, and the high speeds for which they are required, it is clearly undesirable for this arrangement to be used for the higher speed units as the large unsprung weight on the axle would have tended to damage or severely wear the track. The generators of the medium and high speed bogies are therefore supported directly from the bogie frames by brackets, and the generator shaft is geared and connected to the axle by means of Andrews-English Electric flexible axle drives, which were made by the railway under



BOGIE OF BRAKING UNIT

licence. These drives, which were specially developed for use in high powered motor coaches, permit the axle to move vertically perfectly freely, as required by the suspension, and at the same time are self-aligning and permit a certain amount of lateral movement to allow for clearances in the boxes or distortion of the bogie frame.

Considerable attention has been given to the design of the automatic control which regulates the loading of the main generators so that constant speed is obtained. On the dynamometer car a small tachometer generator is driven from the unflanged wheel and generates a voltage proportional to the speed of the train. This voltage is balanced against a fixed voltage representing the speed to be maintained so that the difference represents the error between the actual and the required speeds. This voltage is amplified and transmitted down the train to the braking units in each of which is a thyratron rectifier set controlling the main generator excitation. Stabilising devices are introduced in order to avoid the various forms of "hunting" that would otherwise occur. Each unit has also a master control so that it may be operated independently of the train if desired. The principal controls of each braking unit are centralised in a compartment at one end of the vehicle.

During 1939 several series of tests were carried out on a Class 4, 0–6–0 goods locomotive on the Derby-Leicester-Burton circuit, and further tests were in hand at the outbreak of hostilities. Measurements of the resistance at constant speeds of a number of coaches of standard type are now being made on the line between Rugby and Peterborough.

An accompanying illustration shows one of the test trains in this investigation. The mobile testing unit is marshalled behind the tender and the second vehicle is the dynamometer car, which is measuring the tractive resistance of the eight coaches behind it. A light structure mounted temporarily on the front of the engine carries a cup anemometer and vane whereby the speed and direction of the resultant wind are electrically recorded on the dynamometer chart.

The basic principles of these units were evolved by Dr. H. I. Andrews, of the company's research department, and the subsequent development and construction was shared between the L.M.S. Company's chief mechanical engineer, who built the units in the Derby shops, and the B.T.H. Company, of Rugby, which supplied the main electrical and control equipment.

South African Irrigation and Water Supply Schemes

WHEN in June, last, the House of Assembly voted £2,500,000 to the Department of Irrigation for carrying water from the Vaal to Odendaalsrust, it touched off a vast series of schemes for the regional development of the Union. The Department of Irrigation will supply, as a start, 5,000,000 gallons a day to the new gold mining areas in the Free State. This will be increased by 2,000,000 gallons a year, until it reaches 50,000,000 gallons. For that increase the Vaal dam will ultimately be raised 18ft. With the supply of water as a basis, the whole of the Vaal basin will be developed along with the supply of electricity under the new Electricity Amendment Act, together with transport and roads, and development will be properly correlated and planned to avoid the haphazard growth which occurred on the Rand and, before that, at Kimberley.

Preliminary work has now been started on a great irrigation scheme for the Free State, involving the construction of two big dams at Allemanskraal and Erfenis on the Sand and Vet rivers. It is hoped that in five years the two great dams and about 140 miles of concrete-lined canals will have been completed, that many thousands of morgen of Free State farmlands will be under irrigation, and that within a two-hour car journey from Bloemfontein, there will be two stretches of water, three miles across at the widest point, which will be navigable by boats for about twenty miles. Excavations for the dam walls are expected to start shortly. It is probable, owing to the prevailing shortage of cement, that an earth wall containing a concrete core, may be used instead of the all-concrete wall originally planned for the Erfenis dam.

The Allemanskraal and Erfenis dams, which lie about twenty miles north-east, and twenty miles south-west of Winburg, respectively, are two parts of a possible triple scheme. The third part, which has not yet been definitely decided upon, provides for the building of a wall across the Caledon river. There are two alternative sites, one near to Ficksburg, and the other at Mopeir, north-east of Ladybrand. Whichever site is adopted, this wall will provide the biggest dam in Southern Africa, next to Vaaldam, and will bank up the river for about forty miles. Although the Allemanskraal and Erfenis schemes will be self-contained, the Caledon river scheme will supplement their storage. This projected Caledon river scheme would make it possible to serve two other canals, one of 175 miles along the south bank of the Vet river, and another of 150 miles along the north bank of the Sand river. Water would be supplied from the Caledon river dam when required to keep the Allemanskraal and Erfenis dams up to a certain level. The total provision for the Allemanskraal and Erfenis sections is about £4,000,000.

There are three sites where work is now under way, namely, at Allemanskraal, Erfenis and Virginia (twenty miles north-east of Allemanskraal). Virginia is to be the headquarters of the combined schemes.

The Department of Irrigation is also planning, on a long-term basis, to divide Natal into a series of regions along the watersheds. The first step will be to throw dams across the rivers to conserve as much water as possible for both irrigation and the generation of hydro-electric power. Already men have been drilling the rock on the farm Harlestone, about twelve miles down the Mooi river, from the village of Mooi River, to test whether it will be possible to build a dam there. The dam envisaged would flood seven or eight farms and would form a lake on the scale of Hartebeestpoort, from which as a first objective, the orange groves of Muden could be irrigated. Preliminary investigations have also been made into the possibility of building a dam on the upper reaches of the Bushman's river, so as to regulate its flow and provide a more even supply of water for Estcourt and Weenen lower down.

Only six miles of pipeline now separate Port Elizabeth from Churchill dam, one of the largest in South Africa. This huge scheme on the Kromme river, seventy-eight miles from Port Elizabeth, was started ten years ago and is now expected to be working by October. Its total cost will be about £2,350,000. The pipeline from the dam has held up completion of the scheme, as it was not possible for some time to obtain delivery of the thirty-inch pipes. Churchill dam has a capacity of 7,800,000,000 gallons, and stores up water for nearly four miles. The first pipeline will supply Port Elizabeth with between five and six million gallons a day and provision has been made for two further pipelines of similar delivery. Installing a second line is estimated to cost a further £1,500,000. The need for a very big water scheme for the port became obvious when industrial expansion began to reach large proportions. The existing water supply, from four dams, was about 5,000,000 gallons a day at its best and in times of drought or breakdown those sources were not enough to meet normal needs. The city's industrial development was being planned as long ago as 1937, and it was then decided that eventually more than 11,000,000 gallons of water a day would be required. A survey of the surrounding country showed that only the Kromme river could provide enough water to cope with Port Elizabeth's growing demands. Apart from the dam itself the Churchill scheme entailed building a filtration plant, a new reservoir near the town, and laying the long pipeline. One of the most complicated jobs tackled by the engineers was the building of a bridge, completed recently, to carry the pipe across the Gamtoos river. This bridge is 827ft long, has a middle span of 412ft, and cost about £80,000. It rests on two massive concrete foundations, which had to be sunk into the river bed, one going down to a depth of 97ft. With two additional pipelines installed, the dam could supply about 16,000,000 gallons of water a day—more than enough to meet the next twenty years' development in Port Elizabeth and district. The general structure of Churchill dam has been so designed that its height can be raised without any further blasting being necessary. The capacity of the dam, if raised, is estimated to be the immense volume of 12,500,000,000 gallons. A robot electrical apparatus will govern the flow of water from the dam into Port Elizabeth, the amount flowing into the purification works automatically depending on the city's demand. If there is a flood in the Kromme river and water spills over the sill of the dam as well as down the spillways, a further robot electrical apparatus will automatically open flood gates to a given height, regulating this height by the rise and fall of the flood water. At present a temporary 12in pipeline is bringing an emergency supply of water into Port Elizabeth from the Churchill dam to meet the recent drought conditions. Even now the port is still enforcing limitations of supply to consumers and this will last until the Churchill scheme comes into full operation in October, when Port Elizabeth will have one of the best water supplies in the Union.

A new water scheme has been started along the Durban south coast, where, up to the present, residents have had to depend on rain water for all purposes. This water supply scheme, which is well on the way, will supply water all along the coast from Isipingo to Illovo beach. The water will be drawn from the Nongwana river by gravity to a purification centre. The cost will be over £200,000. The dam supplying the water is to have a capacity of 300,000,000 gallons and the spread of water will be nearly a mile long. Provision has been made for purifying 1,500,000 gallons of water daily.

To stabilise existing irrigated lands, the Government proposes to spend £365,000 on providing water storage on the Ohrigstad river in the Northern Transvaal, by building a dam 173ft high. Expenditure on the scheme this year will be £10,000. Another Northern Transvaal project, which will cost £270,000, with expenditure of £10,000 this year, is to build a dam 86ft high on the Levubu river and to raise by 10ft a diversion weir two miles below the dam site. The object is to overcome water shortages in the Levubu settlements and to expand the irrigated areas. It is intended to establish coloured settlements on the Martin and Krapohl Islands, in the lower Orange river, and a £100,000 scheme to provide irrigation water for the settlements will be started this year at an initial cost of £10,000.

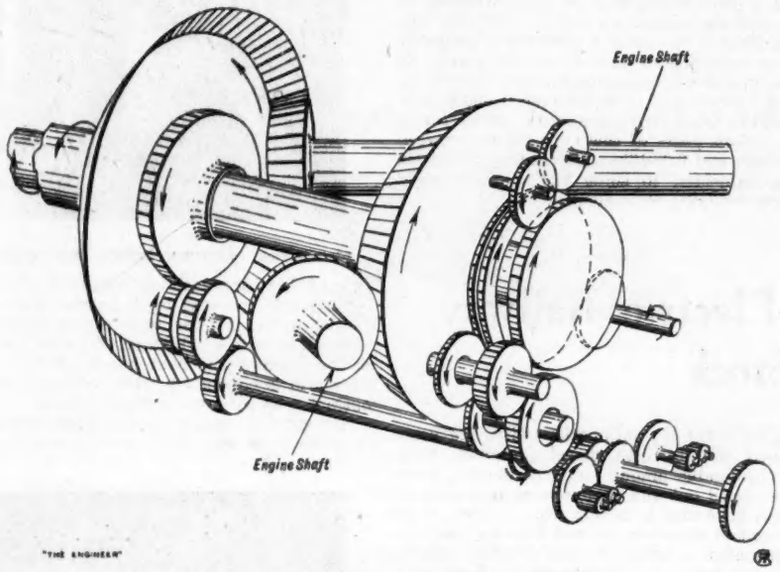
THE LATE MR. H. A. DRANE.—We record with regret the death on August 3rd of Mr. H. A. Drane, service manager of Alfred Herbert, Ltd., Coventry, Mr. Drane, who was fifty-five, had spent the whole of his career in the service of the firm and was particularly well known to production engineers to whom he delivered many lectures on machine tools and kindred subjects. For some time he was chief technical assistant to the late Mr. Oscar Harmer. Mr. Drane was a member of council of the Institution of Production Engineers.

Twin-Engine Gearing for the "Brabazon I"

ENGINEERS with problems of gearing will be interested in the manufacture of the main gears through which the four twin "Centaurus" power units were designed to drive the propellers of the eagerly awaited "Brabazon I" (Bristol 167 Mark I) aeroplane and the manner in which the difficulties were successfully overcome.

The "Brabazon I" is intended primarily for non-stop operation over long routes, such as London to New York (3500 miles), and a consideration in the provision for optimum payloads is utmost economy in fuel consumption. The designers therefore decided that the attainment of maximum efficiency in the power transmission should be a major consideration. A loss in efficiency of, say, 1 per cent involves an increase of about the same percentage in the fuel to be carried for any given trip, resulting not only in a decrease in the payload, but also in an increase in the quantity of heat to be dissipated from each set of reduction gears, and an increase in the weight of oil coolers and other ancillary equipment.

From some two dozen proposals a lay-out was chosen which, other things being equal, used a minimum number of gears, but a serious manufacturing problem was presented in the case of one of the gears, in that no machine tool was known to exist which would be capable of generating an involute form of tooth on an internal bevel gear of the required included angle. However, the Bristol designers, in collaboration with David Brown and Sons (Huddersfield), Ltd., circumvented this difficulty by certain modifications of tooth form, and manufacture was put in hand at the David Brown main works.



DIAGRAMMATIC ARRANGEMENT OF GEARING

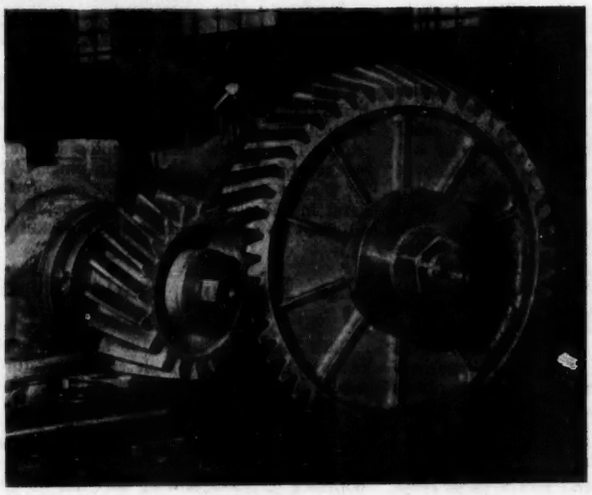
Above is illustrated diagrammatically the vee disposition of the twin-engine driving shaft and the reduction gears housed in a compact gearbox, arranged so as to give independent contra-rotation of the propellers. Each propeller, although coaxially mounted, is driven by its own engine by making the gears driving the inner propeller shaft of the external angle spiral bevel type, and the corresponding drive from the other engine, driving the other propeller shaft, an internal bevel wheel and pinion. As indicated in the diagram, the gearbox also provides various auxiliary drives, with which at present we are not concerned.

Each pair of main gears transmits 2500 h.p. with the engines and pinions rotating at 2700 r.p.m., and at this speed the gears have a peripheral speed of about 7400ft per minute. These figures indicate the importance of careful metallurgical and mechanical manufacture. The external gears raised no abnormal problem apart from selection of a suitable sequence of

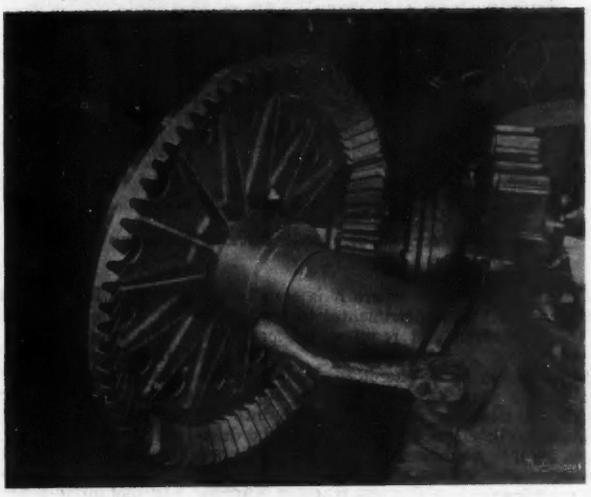
ROUGHING OPERATION ON INTERNAL BEVEL WHEEL

operations with the utmost care and inspection at every stage. The teeth were generated on a 60in Gleason spiral bevel gear generator, this machine being selected as one having the master dividing wheel much larger than the actual running gears, thus giving the accuracy of division which is necessary for work at such high speeds.

The external gears are illustrated on running test below, to the left. It was necessary to control their distortion to fine limits during the hardening process. They are of nickel-chrome case hardening steel—as used for the David Brown spiral bevel rear axle drives for automobiles—machined out of solid discs which had been upset to give the grain disposition best able to withstand the stresses imposed. Intermediate annealing and normalisation to control distortion followed the earlier machining operations and the final heat-treatment were controlled by the use of quenching fixtures. This



EXTERNAL BEVEL GEARS ON TEST



INTERNAL BEVEL GEARS

pair of gears comprises a pinion with twenty teeth, 2·3 D.P. and a wheel of fifty teeth. The teeth have a mean pressure angle of 20 deg., a spiral angle of 22½ deg. and they mesh at an angle of 32 deg. between the axes.

More unusual problems were posed by the internal bevel wheel, which, with its pinion, we illustrate. This pair of gears had to be designed with due regard to the fact that the shape of the rim to carry the internal teeth was such as would be liable to closing-in during heat-treatment, thus disturbing the pitch angle of the wheel with undesirable effect on the tooth marking. It was recognised that this tendency could not be entirely controlled, but only limited by the use of quenching fixtures. This particular gear was therefore machined and, probably for the first time on record, the internal bevel teeth were profile ground.

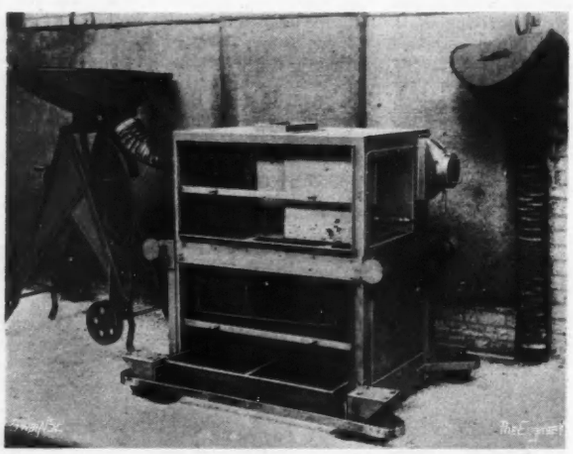
Here developed the more intricate problem, inasmuch as no suitable machine existed for the cutting and grinding of gears of this type and of these proportions. The difficulty was overcome by using the bed and reciprocating mechanism of an Ormerod shaping machine equipped with a special dividing head taking a dividing plate larger than the actual gear to be cut, so that the results would be within the errors on the dividing plate, which shows cumulative errors of 0·0002in. The internal wheel was roughed out with a straight stocking cutter and, using the same set-up, the gear was almost completed by the use of a formed cutter. Following heat-treatment and orthodox bore and face grinding, the gear was returned to the same machine, now equipped with a grinding head.

The gears then passed to a specially constructed lapping machine for the final locating of the tooth marking, after which, as a final test, they were mounted and rolled at low speed in the actual casings. This operation was carried out at full torque by locking together the internal and external wheels, applying the load through one of the pinions and driving the other with an electric motor. Complete testing is, of course, carried out at the engine division of the Bristol Aeroplane Company.

Teeth and pitch of the internal gears differ from the externals, the wheel having seventy teeth and the pinion twenty-eight of 2·8 D.P. with a pressure angle of 20 deg., arranged to run with the axes at an angle of 148 deg. An indication of the success achieved is given by dimensional checks on the internal gears: to take typical results, adjacent errors round these wheels were found to be between 0·0003in and 0·0004in, while the cumulative errors round the various gears of this type varied between 0·0006in and 0·0013in. The gears have so far been subjected to some 300 hours' running under simulated flight conditions.

Dust Removal from Electric Railway Rolling Stock

AMONG the many difficulties with which the Underground railway system has to contend is the accumulation of tunnel and other dust in the ventilating ducts of high-speed rotating units on the rolling stock. This dust, by becoming packed in the ducts, causes a tendency to overheating and upsets the balance of the machines. The normal method of removing this dust by blowing air from a compressing plant through the channels has never been considered an ideal one, since its net result is to stir up the dust and allow it to deposit itself in another place where it is equally unwelcome. It is also detrimental to the health of the operatives and requires the provision of masks, &c.



DUST EXTRACTOR WITH COVERS REMOVED

Experiments have, therefore, been proceeding with a view to providing an apparatus which will not only blow a jet of air into the machine to be cleaned but will draw the dust-laden air into an exhaust chamber and deposit the dust, allowing the clean air to be expelled. A large vacuum machine was made at Neasden Depot, from material ordinarily available, and built up in conjunction with the compressed air jet into a self-contained unit. A considerable amount of experimental work was carried out and various materials such as straw, coke and horsehair were utilised in an attempt to ascertain the best filtering medium. Eventually a machine was evolved which, although bulky and cumbersome, functioned in a satisfactory manner and it was agreed that a firm of ventilating engineers be approached with a view to the design of a compact machine on the principles found by the experiments to be successful. Collaboration between Dallow Lambert and Co., Ltd., and London Transport's Acton works plant section finally solved the problem.

The resulting extractor is contained in a metal case 2ft 4in by 3ft 1in by 4ft high, as shown in the engravings. Its chief merit is that it can be used on the rolling stock in situ, as the illustrations show. It is fitted with small wheels to allow it to be run along under the cars in the examination pit. It consists of a fan driven by a 1 h.p. motor which sucks in the dust-laden air. This air is drawn through a filter, consisting of twenty-five bags stuffed with Sisal grass, which separates the dust and deposits it in a removable tray at the bottom of the container. As the filter bags become impregnated with dust they can be cleaned by agitating a rod which projects for the purpose from the extractor. The clean air is expelled through the outlet grille on the top of the box.

Two special fittings were designed and constructed at Acton to connect the extractor to metadyne machines and motor generators, which are both situated under the cars. A metal funnel, designed to fit over the air exhaust of metadyne machines, is connected by a flexible hose to the extractor intake. The funnel and hose are mounted on a scissors type of elevator, which can be raised or lowered by a screw operated by a hand wheel. The special fitting for use with motor generators consists of a hood which is held over one end of the machine and held in position by cords. This also is connected, when required, to the extractor by means of a flexible hose.

METADYNE MACHINE BEING BLOWN OUT

The current supply for the extractor motor is taken from the 600V d.c. overhead shop trolley circuit and fed to ironclad switch-controlled sockets distributed along the pit wall. The case of the machine is efficiently earthed by the use of three-pin plugs. The air for the jet is supplied from the compressed air main in the shop, a connection being located adjacent to each electric supply socket.

HOOD FITTED TO MOTOR GENERATOR

The Boulton Paul Advanced Trainer Aircraft

THE Boulton Paul P.108 advanced service trainer has now completed successfully its initial flying tests. The aircraft, which is claimed to have the manœuvrability of a modern fighter, has been designed to operate from small airfields. It is intended for instruction in day or night flying, gunnery, navigation, bombing or glider towing and can be adapted for deck landing. Accommodation is provided

for a passenger or navigator as well as side-by-side seating for the instructor and pupil. In the event of an emergency the crew can leave simultaneously through a specially designed parachute exit.

The machine is of the low-wing cantilever monoplane type and is of all-metal construction. It is fitted with a Bristol "Mercury" engine. The overall dimensions are: span, 39ft 4in; overall length, 34ft 4in; overall height, 11ft 10in; span with wings folded, 21ft 1in.

Duplicated flying and engine controls are provided. Push-pull light alloy tubes with

BOULTON PAUL ADVANCED TRAINER

ball bearing joints at the actuating levers are used for the elevator, rudder and aileron circuits. Trimming tabs with cable controls are provided for elevators, rudder and ailerons, using the normal type of hand trimming control. Means of ground setting, independent of the cockpit hand control, are provided. Normal control-locking facilities are supplied. Cockpit heating and ventilation are regulated by a selective control in the cockpit. The hot air is supplied by passing air from the engine air intake through a heater muff on the jet pipe, and cold air, by diverting the intake air direct into the cockpit.

The main undercarriage consists of two single cantilever legs, interchangeable from port to starboard. These legs are pneumatically actuated and retract into the leading edge of the wing centre section. The form of retraction adopted enables a very wide track to be provided. A streamline cover secured to the wheel forms the under surface of the wing with the wheel in the retracted position and obviates the use of folding doors over the wheel aperture. For emergency lowering of the undercarriage should the normal mechanism fail a mechanical release of the up-lock is provided, the unit then falls by gravity alone into the locked-down position. The tail wheel is steerable and of the fully-castoring and self-centring articulated type. The steering is carried out by a connection with the rudder control, which can be disengaged at will from the cockpit.

The fixed gun installation and the alternative camera are situated at the outboard end of the inner wing. Practice bombs are carried underneath the inner wing.

Track and Rolling Stock

ONE of the definite subjects of research undertaken recently by the American Railway Engineering Association is that of measuring and recording the intensity of lateral pressures exerted by locomotives on curves. This constitutes one approach to the problem of improving the riding characteristics of locomotives at high speeds. Devices for lateral resistances of various amounts have been introduced in the trucks or bogies of engines and tenders, as a means of minimising oscillations on straight track, where the highest speeds are attained. On the other hand, these resistances introduce complications in the maintenance of track on curves and through turnouts, where the lateral resistance has imposed excessive lateral pressures, even sufficient to turn over the rail. It is proposed that a curve is to be selected having a curvature not less than 6 deg. nor more than 10 deg.—955ft to 573ft radius. The curve is to be between tangent or straight track approaches long enough for tests of high-speed riding. Roller-bearing base plates or sleepers along the curve will measure the inward or outward lateral pressure exerted on each rail as each wheel of a testing locomotive passes. During 1947 the programme includes the testing of a locomotive of the 4–8–4 class. Tests with engines of other classes will follow. In tests of rolling stock by the same Association, to determine relations between track and rolling stock, one line of study is the investigation of flat spots on car wheels. For this purpose a platform wagon will have one wheel with a flat spot and will be run over the test track while empty, half loaded and fully loaded, being propelled at various speeds. The prepared flat spots will be of three lengths: 2½in, 3½in and 4½in. Observations and records will include the spring deflection and stress measurements on the wheels, axles and frames, as well as the impact effect upon the rails which are subjected to this form of battering.

The Glen Shira Hydro-Electric Scheme

THE North of Scotland Hydro-Electric Board announced early in the week that its project at Glen Shira, known as Constructional Scheme No. 12, has been confirmed by the Secretary of State for Scotland, and that the confirming order and details have been laid before Parliament. Some preliminary particulars of the scheme were published in THE ENGINEER of March 7th last, and it is estimated that the cost will be in the region of £3,150,000. Its construction will employ up to 2000 men, and, as in all the Board's scheme, priority will be given to local labour. The main generating station, with an installed capacity of 40,000kW, will be situated on the main Arrochar-Inverary road at Clachan, near the head of Loch Fyne, and the output of electricity in an average year is estimated at 80,000,000 units. After local demands have been met, the balance will be transmitted to the transforming station which is to be erected at Inveruglas, and from there it will be transmitted to existing lines supplying Glasgow and the West of Scotland. During the preparation of the scheme the Board, in accordance with the Act, consulted the Amenity and Fisheries Committees, and the Amenity Committee recommended that the pipe line should be concealed and that the generating stations should have pitch roofs. The Board has agreed to these recommendations and will later on consult the Committee on the design of permanent buildings. The Fisheries Committee recommended that to preserve the stock of fish in the River Shira the Board should guarantee a continuous flow of 12,500,000 gallons per day above the Kilblaan Burn and also discharge spates of 46,000,000 gallons per day on thirty days in the summer months, and that to preserve the fish in the River Fyne no water should be drawn from the Allt-an-Taillir until the natural flow at the intake point at the aqueduct reaches 5,000,000 gallons a day. The Board was unable to accept these proposals in full, as it was considered that they went beyond what was needed to preserve the stock of fish, and would have reduced substantially the output of electricity from the scheme, which is intended to be one of those from the profits on which uneconomic schemes in the remoter Highland areas are to be financed. After full consideration the Board has, however, provided in the scheme that a minimum flow of 5,000,000 gallons per day will be guaranteed in the Shira at a point near the falls of Drimlee, and that spates of 45,000,000 gallons per day will be provided on sixteen days spread in two-day periods over the months from June to September inclusive. In the case of the Fyne the Board will not take away any water until the flow at the point of abstraction reaches 3,000,000 gallons per day. These proposals are acceptable to the fishery proprietors concerned.

Panama Canal Problems

A MOMENTOUS problem now being studied intensively by engineers of the United States Government is the future policy as to the Panama Canal, basically as to its capacity and its protection from war attacks. Proposals are first to improve the existing canal and build new and larger locks at some distance from the present structures. They would be 140ft wide, as against the present width of 110ft. Their construction was begun as a war measure in 1939, but with the end of the war the work was stopped, pending further investigation of the problem. Secondly, conversion of the existing lock canal into a sea-level canal, with only entrance or tidal locks, has again been brought into prominence, with its difficulties. Studies are being made of excavating machinery of unprecedented size and capacity and also unprecedented depths of under-water excavation. Thirdly, old and new projected routes are being studied for an independent canal at some other point in Central America. This study includes the once favoured Nicaragua route, and also the San Blas route, with its ship tunnel. Flood control would be a primary factor in a sea-level canal, as any side flows entering such a canal would cause serious disturbances and currents. Geology is another factor to be considered, both as to new routes and improvements on the existing route. In accordance with modern developments in engineering studies, the investigations now in progress include not only field surveys and office plans but also laboratory work as to hydraulic conditions, including the use of models of proposed locks and other structures, including flood and tide control. Testing basins are being used for study of the behaviour of ship models in canal models. All this work is in active progress, as Congress has ordered that the report, with its conclusions and recommendations, must be presented before the end of this year. A highly important feature of the report will be the estimates of cost.

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ECONOMIC CRISIS

THE rude abruptness with which the economic storm seems to have broken over Britain is, in reality, illusory. Warnings were given as far back as last autumn, when, after climbing rapidly and promisingly throughout the spring and summer, export figures failed to maintain their upward momentum. Thus, the need to raise production, in face of the imminent exhaustion of the American loan, is now no different in nature, only more urgent in degree, than it was before. As soon as possible a deficiency in our balance of overseas trade, carried so far by drafts upon the loan and running at a level variously estimated at £600 million to £800 million per year, must be eliminated if our standard of living is not suddenly to experience a serious decline. Ever since the war ended we have been trying to achieve that objective by raising output. In fact, however, the advance in our exports has been more than balanced by similar advances in our imports. In face of our failure to achieve a balance by increasing exports, we are forced now to adopt, partially, the alternative of reducing consumption.

It is easy enough so to describe the position. It is not even very difficult, given the necessary statistics, to draw up such a programme of planned expansion of output and reduction of imports as Mr. Attlee put before the House last week. Nor in so obvious an emergency has it proved difficult for the Government to engage the joint support of employers and trades union executives for the programme so laid down. But similar programmes have been planned before. Export volume was confidently expected to reach a level 75 per cent above that of 1938 volume before the American loan ran out. That target is now hopelessly beyond our reach. Exports were to attain a level of 40 per cent above that of 1938 by the end of this year. It is now admitted that such a figure is not attainable. Now Mr. Attlee has set the new target of 60 per cent above 1938 volume by the end of 1948. He did not disguise from the House that it "will be a very difficult target to reach." Since the sellers' market internationally is already giving way, since a number of nations have already closed their doors to imports from this kingdom and since there is little sign of any expansionist policy in world trade, can there really be any confident expectation that such a target can be reached? As the critics of the Government have swiftly pointed out, it needs more than the mere drawing up of a programme to ensure that it is realised.

There is a noble historic flavour about the title of a debate upon "The State of the Nation." But last week's debate failed to sustain that nobility. All the old familiar arguments were again repeated. Government spokesmen claimed the unexpectedly slow recovery of European production as one of the causes of the drain upon our dollar resources. The unfortunate need to import food from "hard" rather than "soft" currency areas was stressed. Difficulties arising out of the convertibility of sterling (difficulties, it may be remarked, which would soon disappear if our overseas budget were more nearly balanced) were discussed. The check to production administered by last winter's fuel crisis was blamed for the failure to raise output. The cause of soaring import figures was discovered in costs inflated since the loan was granted by 40 or 50 per cent. Gloomy references were made to increasingly adverse "terms of trade". Speakers referred to shortages of manpower in this country, to the insufficient output of electric power and to the failure of the miners to lift more coal in five days than in five and a half. It was again implied that bad management in the past had run down this country's resources. So the great apologia continued. But what is the real situation? Despite lower outputs in certain industries, such as textiles, despite all checks administered by shortages of coal and raw materials and power, despite the daily hindrances imposed by priorities, controls and rationing, despite shorter hours of work and higher wage rates, this country is now in all probability producing more than it ever produced before. It is true that the output of coal is so low as seriously to limit the possibility of further industrial expansion. The cause may lie in a lesser will to work of the miners or, as Mr. Attlee claimed, in the possibility that "the run-down of the equipment of the mines has been far greater than we had supposed." But it is nevertheless a fact that in 1938 the home consumption of coal, ample to meet all demands, was 180 million tons, whereas now an annual supply of 200 million tons is barely sufficient, despite fuel restrictions, the rationing of industry and reduced supplies available to domestic markets, to maintain the present level of our industrial effort. Steel production in this country now, limited as it is by insufficient supplies of fuel, is still running at a rate at least equal to the peak output of any pre-war year. Moreover, the Government plans to raise it still further to the unprecedented level of 14 million ingot tons per annum. Our slowly increasing capacity for generating electric power is already 30 per cent higher than that of 1938. Yet it is still so far below the peak demand that to maintain productivity throughout the coming winter it will be necessary to resort to staggered shifts and nightwork. Though the slack of pre-war unemployment has been almost wholly taken up, and though the number of those now employed industrially is nearly half a million greater than it was in 1939, we are still, particularly in the more essential trades, seriously short of manpower. The conclusion seems inescapable that, in fact, appreciably more is now being produced in Britain than before the war. Whence, then, come all those shortages from which we suffer industrially and domestically? The blame for them cannot be found in the diversion of manufactures to the export market, nor even to the loss of imports as interest upon the oversea assets that we held before the war. For, in fact, our imports to-day exceed our exports in volume by an amount closely comparable with that which ruled before the war. We have, that is, on a balance of imports against exports, suffered little or no loss so far in the volume of oversea supplies. Unquestionably, it seems, more goods and services are available for sale in these islands than were ever available before. Yet shortages persist.

In the longer run it is obvious enough that the standard of living of a people is ruled by the amount that it produces. On that basis it seems that, were our productivity better distributed between essential and non-essential purposes, it should suffice to maintain a standard equal to or at least little below that of 1938. But, in fact, encouraged by the American loan, we are trying to maintain to-day amongst our working classes a standard very appreciably higher than that of 1938 To judge, indeed, by the persistent shortages, the standard at which we aim is higher even than that justified by our production plus the surplus of imports over exports. Nor, except by ineffective exhortation and harangue, have the Government or the unions done anything to bring home to workers that so high a standard of living is in fact impossible of attainment under a term of years and then only through a worldwide expansion of trade. Government inaction, indeed, has made a situation serious enough when the American loan was first obtained still more serious now as the loan exhausts itself. Was a time when the raising of productivity was essential if the higher standards promised the working classes were eventually to be attained the right period in which to permit shortened hours of work? In the last six months alone there has been an average reduction of about 3½ hours a week for approximately 3,640,000 people. Was it reasonable when, in fact, standards of living should have been no higher than pre-war to acquiesce so easily in increases of wage rates

that encouraged the expectation of higher standards? For the attempt—the very natural attempt—of the workers to obtain now through their newly acquired spending power what can in reality only be obtained later through heightened productivity has led only to shortages, to priorities, controls and rationing systems. More seriously it has, too, caused a diversion of effort away from those essential trades on whose output we depend for the maintenance of living standards towards others less dependent upon scarce materials and productive only of entertainment or non-essential goods. In excess of purchasing power, in fact, can be found the main cause of the maldistribution of labour and the prime reason why in a time of unprecedentedly high productivity we still suffer severely from the lack of essential goods. Unfortunately, the effect of the Government's uninspiring crisis programme, as announced last week by Mr. Attlee, must be to reduce still further the supply of goods available for purchase, whilst simultaneously increasing the demand thus further exacerbating an already sufficiently unfortunate situation.

The overriding present need, it seems to us, is to bring home, particularly to the workers, that the present productivity of this country, high though it is, really only justifies the maintenance of a standard of living little, if at all, better than that of 1938; that their present prosperity relatively to that of other classes is enjoyed only as a consequence of the use of the American loan; and that the standards promised them by the Labour Government can only be attained by raising national productivity to levels far above those ruling in 1938; in short, to convince them, and indeed all inhabitants of this country, that their standard of life depends, not upon monetary rewards for their labour, but upon their productivity. But the Government's proposals to adjust the reduced supply to the enhanced demand by the imposition of yet further regulation and control and its insistence upon the need for powers "for ensuring that the whole resources of the community are available for use and are used in a manner best calculated to serve the interests of the community," can have no such effect of convincing the population of the reality of our economic troubles. It seems more likely, indeed, by the further rationing of essentials, to press excess purchasing power into channels even less desirable than those chosen at present. The more rational policy of calling upon the nation to work longer hours without increase of earnings would no doubt arouse the angry objection of the unions. The remaining alternative is to adopt that policy, deflation, which has Sir John Anderson amongst its advocates and which has been fully discussed recently by our contemporary *The Economist*. That policy must, we think, lead inevitably, if only temporarily, to some increase of unemployment. But without requiring direction of labour or the imposition of controls and priorities it seems likely automatically to cause a transference of labour from non-essential to essential work. Moreover, it would make the real economic situation felt directly in the pockets of the people. In the debate Mr. Dalton expressed his pleasure in the growing surplus of the national Budget. His speech, too, included the warning that "some capital developments, most desirable in themselves, . . . must none the less be put behind the export drive in terms of priority." Such symptoms suggest that willy-nilly the Government is being driven by economic logic to adopt just such an expedient.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SCIENCE, LIBERTY AND PEACE

SIR,—Mr. Felton and I seem to some extent to be performing the time-honoured operation of arguing at cross purposes. It might be as well, therefore, if I tried to limit and clarify my point.

I thought and still think that Mr. Felton is inclined to blame the Technologist for some of our trouble and wishes to undo some recent technical changes such as mass production, centralised organisation and so on. I expressed and repeat my view that such an attitude to our troubles is mistaken and fruitless, although I admit it is very popular and springs from a very deep-seated aspect of human thought and behaviour.

Technical conditions and their changes and trends are the product of previous conditions stemming back into ages long past; they are, in fact, predetermined conditions as much beyond our immediate control as the prevailing level and distribution of population or existing National States, and to blame them for our troubles (or to hope they will cure them!) is to exhibit in a new form that savage ignorance we associate with primitive gods and sacrificial ceremonies.

The gods of mass production, centralised organisation, speed and so on, are no more likely to cure our troubles than are the gods of war or fertility—but neither are they the cause of them.

A primitive shepherd could have been and probably was as much a "specialist" (*i.e.*, limited and ignorant) as any modern machine tool operator. A primitive tribe under its chief or priest was as "centralised" as any modern dictatorship. Our troubles are due not to technical conditions but to our inability to accept and use them wisely. My whole point is that instead of grumbling about them and saying they ought to be different we should learn to live with them. Please note that I do not advocate this course because I think the conditions are good; I do so because only by accepting and living with them as wisely as we can shall we learn how to modify them wisely and have the energy to do so successfully. Most of us expend so much time and energy kicking against the brick walls round our garden that we never make the best of what it contains nor have any time for developing sound ideas on how it should be modified. Mr. Felton may claim that he has developed sound ideas on how it should be modified and that the purpose of his letter was to explain them, but that is the precise point of our disagreement.

In the first place I think Mr. Felton's desired modifications are bound to be impractical, since they involve going back to where we were; a process contrary to all experience. In the second I join issue with anyone who asserts that he knows what is wrong with present conditions and how they should be changed because I fail to see any signs that we have shown any ability to make the best of what we have.

Change will continue whether we like it or not, stemming, as I have said, from the past; but the only part of that change we have as yet any right to try and guide is the change in our own attitude which will enable us to concentrate first on living wisely under such prevailing conditions as we may meet. When we can do that we may have enough wisdom and spare energy to guide wisely the trend of change in our technical environment.

It is the old story of trying to run before one can walk, of blaming others for one's own faults, of scapegoats and myths. "I know what is wrong." "We must have more babies." "Why split the Atom?" "Do away with mass production." "World Government will save us." "Science will make life wonderful (or hell!)." "It's all the fault of the Technologist." None of these ideas should be present in the mind of an intelligent man when he is writing for an intelligent reader.

H. G. P. TAYLOR.

Shoreham-by-Sea, August 10th.

SIR,—Mr. Felton, in his letter of August 8th, starts his reply to my remarks by a rearrangement of the words I used, which distorts my meaning and makes it easier to answer what I did not say.

If the application of Science and Capital (I did not say "mass production") to agriculture will enable the peasant to produce more food by less work, good luck to him—this will not "extend the alleged struggle," but will give the peasant fairer play and the people better rations. The difficulty of maintaining agriculture in this country is due primarily to the objection of urban populations (of all classes) to give fair value for the food they consume, an objection which their preponderant voting power and their political organisation has enabled them to sustain. Finally, I agree with Mr. Felton that "the case for a reversal of the present industrial and social trends from centralisation to decentralisation is formidable and far-reaching," but I find it difficult to relate this opinion to the body of Mr. Felton's two letters.

F. L. WATERS.

Lyndhurst, Hants, August 11th.

PREMIUM DAYS

SIR,—The new export targets for 1948 make increased output of the engineering and allied industries of vital importance. It is to be hoped therefore that the Government and trade unions will agree on the abolition of certain practices in these industries.

I refer in particular to the so-called "premium days" which follow every bank holiday. Men working on "premium days" are entitled to overtime rates, a system justified when workers' holidays were largely limited to bank holidays. Now, when the working week has been reduced and workers in the engineering industries are entitled to a week's holiday with pay, plus six paid bank holidays annually, "premium days" are out of keeping with economic realities. Indeed, many firms find themselves compelled to close on such days, with the result that the workers' pay packets are depleted.

I know from long investigation of the prob-

lem, that a large percentage of employees, now barred by union rulings from doing so, would be glad to work on "premium days" at normal rates of pay.

Is it not time that this survival from the past should be abolished in the National interest?

LEWIS D. LEVY.

London, W.12, August 9th.

SHORT NOTICES

Cost Ascertainment Methods for the Ironfounding Industry. The Council of Ironfoundry Associations (April, 1947). Price £2 2s.—In 1943 the Council of Ironfoundry Associations appointed a committee "to investigate costing methods in the ironfounding industry and to formulate a system of cost ascertainment based on uniform principles." The system finally evolved by the committee has been approved by the Council and its adoption by the industry is strongly advocated. The details of the system are set out in this book, which has recently been distributed to all members of constituent commercial associations of the Council. The introduction points out that the system is described in such detail that it can be applied by the majority of founders; it can be expanded for ironfoundries requiring greater particularisation of information, and contracted by smaller or less complex foundries. The principles, purposes and benefits of cost ascertainment on a uniform basis are briefly reviewed in Chapter I, and Chapters II to VI describe and explain the system under the headings "Requirements for Cost Ascertainment," "Classification of Expenses," "Departmentalisation and Allocation of Expenses," "Metal and Melting Costs," "Absorption of Expenses into the Costs of Work Done."

The application of the scheme is demonstrated in Chapter VII. Reference is made to a master plan (Appendix I), which covers the departmentalisation of the ironfoundry and its ancillary departments, and the classification, apportionment and absorption of all expenses. Appendices II to V reproduce examples of the periodical cost analysis, the trading account, the job cost ascertainment sheet and estimate sheets. The charts and the letterpress are bound ingeniously into a twin-folding board cover, which makes cross-reference easy.

Circulation of the book was originally intended to be confined to the members of constituent commercial associations, but the Council has now decided that non-members may be supplied with copies at the price stated. Applications, which should be accompanied by a remittance, should be sent to the Secretary, the Council of Ironfoundry Associations, Derbyshire House, Belgrave Street, London, W.C.1.

BOOKS RECEIVED

Manual of Photogrammetry. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 45s.

Second Year Radio Technology. By W. H. Date. London: Longmans, Green and Co., Ltd., 43, Albert Drive, S.W.19. Price 7s. 6d.

Six-Place Tables. Seventh edition. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 12s. 6d.

"Shipping World" Yearbook. Sixtieth edition. London: *The Shipping World*, Effingham House, Arundel Street, Strand, W.C.2. Price 20s.

Thorpe's Dictionary of Applied Chemistry. Fourth edition. London: Longmans, Green and Co., Ltd., 43, Albert Drive, S.W.19. Price 80s.

Dynamic Motion and Time Study. By James J. Gillespie. London: Paul Elek (Publishers), Ltd., 36–38, Hatton Garden, E.C.1. Price 7s. 6d.

Modern Assembly Processes. Second edition. By J. L. Miller. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 18s.

Co-operative Research in Industry. By Douglas W. Hill. London: Hutchinson and Co. (Publishers), Ltd., 47, Princes Gate, S.W.7. Price 10s. 6d.

Mine Economics. Second edition. By S. J. Truscott. London: Mining Publications, Ltd., 482, Salisbury House, London Wall, E.C.2. Price 35s.

Powder Metallurgy

No. V—*(Continued from page 121, August 8th)*

SECTION E.—POROUS METAL COMPONENTS

Dr. W. D. Jones presented the papers on Section E:—(15) "The Structure of Porous Bronze Bearings," by A. G. Metcalfe and A. Carter; (16) "Highly Porous Metal Compacts with Special Reference to Filters," by C. E. Sinclair; (17) "De-Icing Equipment," by T.K.S. (Aircraft De-Icing), Ltd.

Messrs. Carter and Metcalfe had made experiments by sintering compacts of 90 per cent electrolytic copper and 10 per cent atomised tin powders mixed together, with and without 1 per cent of the copper replaced by graphite, and using either coarse or fine tin powders. The speed of diffusion of the two metals in these compacts was, of course, greatly increased by the fact that the sintering temperature was well above the melting point of tin. The sintering temperature was important. Below 800 deg. Cent. the final product consists of interconnecting porosity, and above it the pores are isolated.

The exact nature of the porosity in porous bronze bearings was presumably a matter of considerable importance, and one would expect that the more satisfactory bearing would be made with an interconnecting porosity. The compressive strength of the bearings reaches a maximum as the sintering temperature rose to and above 800 deg. Cent.

The paper by Mr. Sinclair described the preparation and properties of porous bronze filter materials containing 11 per cent of tin. Because the product averages a porosity of some 37 per cent it has, of course, poor mechanical properties, which, however, were very much superior to those of ceramic filter materials used for similar purposes. These materials were being successfully used for the filtration of oil engine fuel, for air infiltration and for the filtration of petrol and paraffin, and the author particularly referred to the treatment of water. Another typical application of porous metal is described in the paper on aircraft liquid de-icing equipment by T.K.S. (Aircraft De-Icing), Ltd. The T.K.S. system consists of a tank containing the de-icing fluid, a porous filter to take dust out of the fluid, a pump capable of delivering up to 22 pints an hour of fluid with a maximum pressure of 225 lb per square inch (which, however, can be varied indefinitely) and sets of porous metal distributors made from a copper-nickel-tin alloy.

DISCUSSION

Mr. M. M. Hallett (Sheepbridge Stokes Centrifugal Castings Company, Ltd., Chesterfield) said that this section of the symposium was of particular interest, because it dealt with applications which make use of the unique properties of porous metal components, and not merely with powder metallurgy as one of the alternative means of reaching some desired end. Of the three papers, that by Mr. Sinclair in particular emphasises the importance of the form of the porosity in the component. He would suggest that one of the problems for the proposed study group would be the formulation of standard methods of expressing the characteristics of the pores in powder metallurgy components.

Mr. V. Morgan (Bound Brook Bearings (G.B.), Ltd., Birmingham) said that it was difficult, if not impossible, to judge the continuity of porosity on a two-dimensional plane (for example, by microsections); it was far better to use some other type of test in order to investigate the nature of the porosity. Such a test would be a permeability test, whereby either liquids or gases were caused to permeate through the walls of the bearings. Far from the type C bearing having, as the authors of the first paper had concluded from their photomicrographs, a system of non-intercommunicating pores, it had, in fact, quite good permeability.

With regard to the other experiments of the same authors, using electrolytic copper with 10 per cent of tin, he found that a temperature of round about 800 deg. Cent. was in some way critical, but it was not merely a question of raising the temperature above or keeping it below 800 deg. Cent. Such factors as the density of the compact, the rate at which the pieces are heated, the properties, origin and past history of the powders used, the time for which the specimens are held at the temperature, the gradient of the isothermal across the bearing itself, the atmosphere, and even the presence of lubricants, were important. He inquired whether the authors had given the bearings a running test. He had found that the greater the sintering temperature the greater the permeability, and also the greater the tin content the greater the permeability. That was the reverse order from that in which the authors had classified the three bearings.

A bearing with type C porosity did not give a poor running performance, and it would not be fair to condemn the running performance of a bearing merely on the appearance of its microstructure.

Dr. P. R. Marshall (Ferodo, Ltd., Chapel-en-le-Frith, Cheshire), commenting on the remarks made by Mr. Morgan, expressed the opinion that the method of forcing liquid through the pores of these porous metal compacts was all right when they were to be used as filters, but as a general means of finding the porosity it could lead to incorrect results, inasmuch as different figures could be obtained from the same area according to whether there were a few big holes or a large number of very small ones.

Mr. P. D. Liddiard (Glacier Metal Company, Ltd., London) said he was struck by the difference between the types of powder used in these different porous objects. On the one hand, we had the porous bearings, which seem to utilise dendritic electrolytic powder for their copper content, and on the other hand, we had the porous filters, which use essentially spherical powders. Judging by the photomicrographs shown in the paper by Carter and Metcalfe, the type of porosity in the bearings was extremely irregular, both in size and in shape, whereas the type of porosity which was obtained in the filters, as indicated by the photomicrographs in Mr. Sinclair's paper, was certainly much more controlled both in size and in shape.

One method of determining the difference between interconnected porosity and non-interconnected porosity would be by differences in density determination with and without the presence of oil, and such experiments do give an indication of the amount of interconnected and non-interconnected porosity.

He felt that the density figures given in the paper by Carter and Metcalfe would have been more useful if they had been given after the extraction of oil. He imagined that the

figures shown in Table I were with the presence of oil. If they had been given without the presence of oil we could have obtained some indication of the degree of porosity, having a knowledge of the densities of the fully compacted material. We were given the compositions, and it would be possible to find out the densities of the fully compacted materials, and from that get an idea of the ultimate density with regard to the porosity of the bearings in question.

He agreed with Mr. Morgan that the work had been done around a very critical composition as regards tin content. Variations in the tin content, in time and temperature of heating, and in the conditions of cooling would make a very big difference to the ultimate structure.

Dr. C. H. Desch, F.R.S. (President, the Iron and Steel Institute) called attention to the methods which were used in the cement industry for determining the total porosity and also the interconnected porosity. It could be done easily by using a liquid which penetrated readily. In the case of cement xylene was always used. By comparing the amount of liquid taken up with the known density of the material, obtained either from the knowledge of the particular alloy or from the determination of the density of finely crushed material, one could obtain both the total porosity and the interconnected porosity.

Mr. A. Carter (Powderloys, Ltd., Coventry), in reply, agreed that the difficulty in judging the porosity of bearings simply from a two-dimensional photograph was very great. They had intended to pursue some permeability experiments on these bearings, but that has not yet been done.

It was not merely the permeability, but the retention of the oil in the bearing which was important. Oil would only be retained in blind pores after impregnation and not in continuous capillaries. They had not conducted any running tests on those bearings.

Mr. C. E. Sinclair (Sintered Products, Ltd., Sutton-in-Ashfield), in reply, said that, as Mr. Hallett had indicated, the key requirement for purposes of filtration and aeration was the shape and type of porosity. In porous bronze bearings, it would not seem to be essential that every pore should be of uniform size, but in material used as a filter or to aerate a liquid with a gas of uniform bubble size, every pore should be of as nearly the same size and shape as possible. That could be achieved only by using spherical-shaped particle powders.

With powders not of spherical shape it was almost impossible to produce uniform grades of material by the normal methods of screening powders to various fractions, and the flow figures obtained from those compacts had been very irregular indeed.

Captain R. R. Rawson (London), replying to the discussion on the paper by T.K.S. (Aircraft De-Icing), Ltd., said that the problem of de-icing was rather far separated from that of powder metals. To get uniform flow, they had had to depart from the idea of control by the porous metal itself and had had to use capillary tubes in the distributors, so that variations in the porous metal had little effect. The pressure drop through the porous metal was less than 0·05 of the total drop, so that slight variations in the porous metal had very little effect on the overall efficiency of the distributors themselves.

The Manufacture and Properties of Sintered Ferrous Components

At the afternoon session on Thursday, June 19, 1947, the Chair was taken by Lieut.-Colonel Lord Dudley Gordon, (President of the Institution of Mechanical Engineers).

In the absence of Mr. J. A. Judd, Dr. L. Northcott (Armament Research Department) presented seven papers dealing with sintered ferrous components, forming part of Section F of the Symposium.

Section F.—"The Manufacture and Properties of Sintered Components": (18) "The Properties of Certain Iron Powder Compacts," by J. P. Burr and W. Clark; (19) "Iron-Carbon Alloys by Powder Metallurgy," by J. A. Judd; (20) "Observations on the Pressing, Sintering, Heat Treatment and Properties of Iron-Graphite Powder Mixtures," by R. Chadwick and E. R. Broadfield; (21) "Sintered Iron-Copper Compacts," by L. Northcott and C. J. Leadbeater; (22) "Observations on the Pressing, Sintering and Properties of Iron-Copper Powder Mixtures," by R. Chadwick, E. R. Broadfield and S. F. Pugh.

Dr. Northcott said that the first paper by Messrs. Burr and Clark dealt with the effect of length on the density of iron powder compacts of simple form, and the loss in pressure due to the die-wall friction.

The next two papers, one by Mr. Judd and one by Messrs. Chadwick and Broadfield, dealt with iron-carbon alloys and their preparation by powder metallurgy. Mr. Judd described briefly the three methods for making iron-carbon (*i.e.*, steel type) compacts. In the first instance, it was possible to start off with steel type powders, the disadvantage being that the compacting properties of steel type powders are poor. By the second method one could start off with a soft iron powder and mix graphite with it. At a temperature of 1000 deg. Cent. or thereabouts the carbon went into solution, and on cooling gave a steely type of material. The disadvantage of that process was that the material was very susceptible to decarburisation, and also to lack of uniformity in carbon content throughout the compact.

The third method was to use a soft pure iron and introduce the carbon mainly in the form of an iron carbide, which either melted or approached the melting point at the sintering temperature. If necessary, further carbon could then be added in the form of graphite. The author went on to discuss the preparation of sintered iron piston rings, and by the third technique seemed to have attained in practice at any rate a very close approach to what was wanted in piston rings. One advantage of using his third method was that by using an alloyed carbide it was possible to introduce alloying constituents into the compact fairly readily.

The third paper, by Messrs. Chadwick and Broadfield, dealt with the pressing, sintering heat treatment and properties of iron-graphite powder mixtures. They employed three varieties of iron, an electrolytic iron powder, a Swedish powder and a German powder made by the Degussa process. Their compacts produced from iron-graphite mixtures were in the form of small rings, approximately 1in in external diameter, 0·1in in wall thickness and 0·2in in height. These were sintered in an atmosphere of cracked ammonia and subsequently examined. Mean carbon loss was reduced to nil only by the addition of propane to the furnace gases, but a close approximation was obtained by partial protection from the furnace atmosphere. The authors investigated the effects of the added graphite, of sintering temperature and sintering time, and of hardening and tempering technique. Certain anomalous results in the mechanical properties after hardening and tempering may have been due to ineffective quenching, resulting from the lower heat conductivity of a porous material relative to that of a solid material.

There followed two papers on iron-copper compacts. Northcott and Leadbeater studied the properties of sintered compacts containing additions of copper to iron. They examined a variety of irons and a variety of coppers, and found a maximum tensile strength in the neighbourhood of 20–25 per cent of copper. They examined the effect of sintering temperature in relation to the melting point of the copper, and showed that for optimum effects the copper should be liquid. In porous compacts the maximum tensile strength occurred at about 10 per cent of copper.

The next paper was by Chadwick, Broadfield and Pugh. As in the case of their iron-graphite paper, these authors used compacts in ring form. Certain of their results were very similar to those in the previous paper. The maximum tensile properties were shown at a copper content in the region of 20–25 per cent. These authors investigated the effect of variation of particle size, and of different processing conditions.

The other two papers dealt with the position of powder metallurgy in Germany. According to Mr. Leadbeater's paper over 32,000 tons of iron powder were prepared in Germany in 1944, and the projected production for 1945 was about 56,000 tons. In the earlier stages of the war the Hameteg process was the one mainly used, but later on the atomisation method, the Disc process and the RZ process were coming into some prominence. The question of die design had been gone into very thoroughly in Germany, and it is quite possible that we may benefit to some extent from the experience of the Germans during the war. The paper concluded with a useful appendix in the form of an index of references to powder metallurgy in various B.I.O.S. and C.I.O.S. Reports.

Colonel Ivory reviewed the methods of making the powders and the types of powder produced, and gave details of value and interest in connection with a special application of sintered iron.

Discussion

Mr. D. A. Oliver (Director of Research, the B.S.A. Group of Companies) said that the papers showed that the scientific foundations of the powder metallurgy of small steel and non-ferrous components were now being firmly and surely laid. In an engineering component, he thought that it would be a difficult task for the powder metallurgy method to fight the older methods unless they could select uses where very large numbers of a component were needed on strictly standardised lines. The cost of tooling up some of these components was extremely high. The plant overheads were very high if the plant were not fully occupied, which meant that something must be done to even out the load on a given plant. If engineering components could be found which were wanted in vast quantities—millions—there would be very good hopes for the new method, and the papers which they had had were going to help them in getting higher strengths and engineering properties that were worth while.

Although it appeared that steels made from powders had advanced in Germany to a fairly high degree of technique on an experimental footing, there was not very much evidence to show that a great many spectacular components had gone into production. In America he thought that they had made greater advances commercially, but the properties were inferior to a good many of those recorded in these papers. He had

heard the position aptly summarised recently by the statement that the American powder steels were comparable with ordinary cast irons.

He was sure that with a little further work the powder metallurgist would soon be able to show properties which were extremely competitive with the properties of simpler materials machined or precision cast. There were, therefore, three methods: the moulding method from powders, the precision casting method, and the direct machining method. Those three methods should be considered side by side for components which had to be really mass-produced, and for components which could be very severely standardised.

Mr. R. J. Brown (Nuffield Central Research Laboratories) wished to say a few words as a representative of the user. The powder metallurgy application to the production of carbide tools, sintered bearings, porous bearings and filters had been well established for a great many years, and there was no doubt that such components fulfilled a vast need and showed a considerable advance over older materials; but when they turned to the iron-graphite powders, the iron-graphite compacts, they found rather a different story. He had had a somewhat unfortunate experience in using as an alternative to cast iron a sintered iron-graphite component which unfortunately disintegrated in use. Sintered iron components having only the strength of cast iron would suit very many applications. Even the American components do not approach cast iron.

This disintegration of the components appeared to be related to some variation in density stated to be due to the poor flowing properties of the powder available at the time, but examinaton of numerous components produced by powder metallurgy indicated that this variation in density was a problem which had not yet been overcome. It had been stated in the discussion that morning that the density would vary from end to end of the compact, and presumably from the sectional surface to the mid-way position in the section.

Mr. Brown emphasised the need for development work on hot coining or hot pressing. The properties given for hot pressing, as reported in the American technical press, certainly approach the properties to be obtained in normal steel, taking tensile strength and elongation as the criteria; impact values were not quite so good. It was interesting that Northcott and Leadbeater emphasised the importance of cohesion, because it was obviously this lack of cohesion which caused the properties of sintered iron-graphite compacts to be so low, particularly when tested by impact. It appeared essential that the metallurgists associated with this new metallurgical development should pay considerable attention to obtaining satisfactory strength, ductility and impact value in his product.

At one time he thought that the engineer—with all due deference to their chairman, Lord Dudley Gordon—was rather a nuisance, because he seemed to prefer the hammer as a method of testing to any other test procedure; but as he had grown older he had come to the conclusion that the hammer was a very useful test, and even the much-maligned Izod test was also a very useful test. Until the impact properties and ductility of the iron-carbon powder components could be improved, he saw very little hope of their general adoption in the engineering industry. He agreed that they had scope for specialised application, as in porous bearings, where there was plenty of support, and in sintered bearings with steel backs and for the cutting of materials.

Dr. W. D. Jones (consulting metallurgist, London) said that while he could not undertake to answer the points which Mr. Brown had raised he had a few comments on some of the papers relating to these matters. Mr. Brown was correct in saying that bad density distribution is one of the current defects of the products of powder metallurgy. A paper from the school of Professor Wolf, published by the American Institution of Mining and Metallurgical Engineers, showed that lubrication of the die led to a much higher density and a very much better distribution of density across a component than lubrication of the powder by adding a lubricant to it. He drew particular attention to that paper, because it seemed to him to be a very important one, which had so far tended to be overlooked. He felt that if manufacturers in the powder metallurgy business were to give some attention to the possibility of lubricating the die automatically, better products might be obtained without the worry of adding lubricant to the powder.

Mr. Brown had suggested that possibly one of the steps towards getting a more satisfactory component was to use hot pressing. He (Dr. Jones) had always been an enthusiast for hot pressing, and so far had been a little disappointed that it had not been commercially used to a greater extent. Mr. Judd, in his paper, suggested that the high-tensile strengths and high densities which had been obtained by the hot pressing of powders in air might be partially due to decarburisation because no precautions were taken to provide a suitable atmosphere. He added: "This need for the provision of a non-oxidising atmosphere . . . is the obvious commercial limitation of the hot-pressing technique." That, thought Dr. Jones, was wrong. The hot-pressing work to which he referred was done deliberately in air, because it was found that much better results were obtained in air than in a protective atmosphere. The results were not due to decarburisation, because very excellent results had also been obtained with brasses and bronzes.

The hot-pressing technique needed to be studied more closely to get good results, but the real difficulty was not the question of protective atmosphere but of die materials. That had already been discussed in connection with the carbide papers. If we press at temperatures of the order of 800 deg., 900 deg. or 1000 deg. Cent., so far the only die materials which appear to be available are materials of the order of graphite, which have a very poor tensile strength and which seriously limit the pressures which can be used. Moreover, of course, such materials wear very quickly, and it is not possible to keep within close tolerances for very long.

He wondered whether, in studying hot pressing, the possibilities of techniques which were used in other branches of metallurgy—for example, drop forging—had not been overlooked. He, himself, was of the opinion that the best method, from an industrial point of view, of producing large quantities of hot pressings cheaply would be to press the powder cold, heat up the compact as quickly as possible to the sintering temperature, which perhaps could be best done by induced high-frequency current, and then forge the hot compact in a cold die. That, he thought, would get round the difficulty of the hot die. Work had been done along those lines, and in America the Chrysler people had fashioned some steel components in much that way. He thought that the process needed elaboration, but was sure that it did not need a protective atmosphere.

He would like to amplify what was said in Mr. Leadbeater's paper about the D.P.G. process, also referred to in other papers as the Disc process or as the Comminution process. It was developed about 1937 or 1938 by the Deutsche Pulvermetallurgische A.-Gesellschaft in Frankfurt, and arose out of one of their methods of comminuting or granulating chemical materials. It consisted then of an aperture through which molten metal was poured, a fairly large diameter cone of water, and a rotating wheel or wheel with radiating spokes or knives on it which rotated at a high speed—4000 to 6000 r.p.m. The cone of water was brought more or less to a focus on this rotating wheel, and the technique involved was a breaking up of the molten metal by the moving knives and the immediate freezing of the particles by the surrounding water. That was how the machine worked.

Two of these machines were installed in this country during the war, one in Darlaston, working on iron, and the other in London, working on non-ferrous metals. As far as he knew, the Germans made very few changes in the machine after Dr. J. E. Hurst and he had obtained the drawings in 1939, and he would like to point out that both these machines were extremely unsuccessful.

Molten metal was thrown on to the rotors and built up on them, so that the machine had to be stopped at frequent intervals to remove it—if it did not come off itself in one large lump and go through the casing. The powder produced had a very high oxide content, generally of the order of 1–3 per cent, and the machines were eventually replaced by atomising methods, which were considered to be an improvement.

The question arose of why the Germans had gone on using these machines when they were unsatisfactory. Mr. Leadbeater and others had pointed out that they were unsatisfactory in many ways. There were large numbers supposed to be working, of which a considerable percentage at any time had broken down. It was also clear that the powder produced by these machines was invariably reduced before use, which was the way in which they got round the high oxide content. He imagined that the German technicians, being pressed for a large production of powder, quickly seized upon a method which gave reasonably good results and just duplicated those machines, made as much as they could, and then took their time to improve the methods. Perhaps Mr. Leadbeater would be able to say whether similar remarks could be made about the Hameteg process. Dr. Jones said that he had noticed the growing interest everywhere in the D.P.G. process, and it was with the idea of telling these home truths about it that he had decided to make these remarks.

(To be continued)

COPPER CYLINDER FROM ANTARCTICA.—Found lying in the snow on McMurdo Sound, in Antarctica, a copper cylinder containing a message left by the Shackleton Expedition of 1914-17 has now been returned to this country. It was found last February by Rear-Admiral R. H. Cruzen, of the U.S. Navy Antarctic Expedition, and was recently handed over by him to the British Embassy in Washington. The cylinder has been sent to the Copper Development Association for examination. It is 6in long and 1¼in in diameter, being made from sheet or strip about 24 s.w.g. thick, with a beaded edge at the open end and a soldered seam down one side and round the bottom. Most of the outside surface is covered with a thin layer of dark green patina, the absence of which in places suggests that the cylinder may at some time have been clipped to a support, perhaps to the cross erected by the Shackleton search party in 1917. The copper at all points is in perfect condition and shows no sign of deterioration. The design and workmanship of the cylinder suggest that it may have been made by a member of the expedition in either a ship or camp workshop.

An Alternative Form of Pressure Vessel of Novel Laminar Construction*

By H. BIRCHALL, B.Sc. Tech.,† and G. F. LAKE, M.A., A.M.I. Mech. E.‡

Introduction

Owing to the rapid and continuing increase in processes which involve reactions at elevated pressure, much attention has been given in certain branches of the chemical industry to economic design and construction for vessels suitable for various pressures up to many thousands of pounds per square inch. Until about ten years ago, riveted vessels were generally used for the lower range of the pressures concerned and forged for the higher pressures. The development of suitable electrodes and methods of welding, combined with the very important radiographic examination of welds, made it possible to design, and use

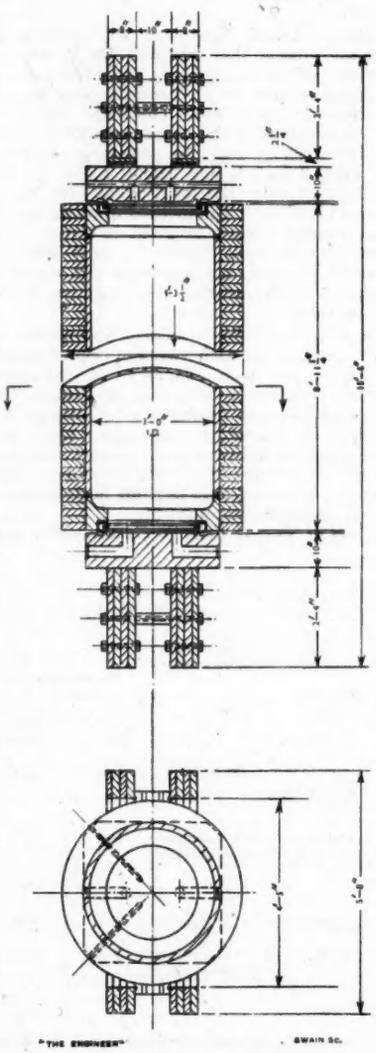


Fig. 1—*Short Squat Laminar Vessel*

with confidence, welded vessels for elevated pressure. Much practical use has been made of this welding development, but at the moment its further extension is limited by the fact that it is confined, for metallurgical reasons, to relatively low-tensile steels and, even with these materials, to wall thicknesses not greater than about three inches. A further difficulty is that of bending thicker plates to the required diameter; this, however, awaits design of suitable equipment rather than any fundamental development. Nevertheless, the so-called Class I welded pressure vessel is now well established and fills an extremely important place in chemical and power plant engineering design for what might be termed intermediate pressures.

An ingenious development of the welded pressure vessel was that put forward by Messrs. A. O. Smith in the United States, and generally known as the "multi-layer" pressure vessel. This consists essentially of an inner vessel, having a longitudinal weld,

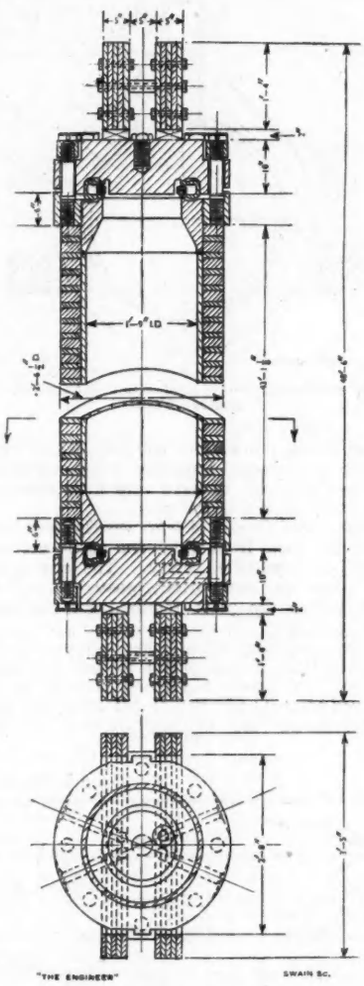


Fig. 2—*Long Thin Laminar Vessel*

built up to the required thickness by wrapping on and welding successive layers of relatively thin plate. The multi-layer cylinder constructed in this manner is then subjected to very high internal pressure in order to consolidate the layers. Forged end-connections are welded to the multi-layer body in order to complete the vessel.

As mentioned above, most vessels required for chemical reactions at really high pressures (3000 lb–5000 lb per square inch) have in the past been made as forgings. In order to reduce the capital and running costs of ancillary plant and to make control more effective, the designers of these vessels aim at obtaining as large a reaction volume as possible; and the size of the vessel, made as a forging, has generally been restricted by steel making and forging limitations rather than by any limitations on the engineering design aspects.

A forged vessel of, say, 4ft internal diameter and 40ft long, suitable for 350 atmospheres, would, with its integrally forged enlarged ends, have a finished machined weight of about 70 tons. To make such a vessel it is necessary to start with an ingot of 220–250 tons weight in order to cover the loss of metal involved in croppage of the ingot, trepanning of the central core, losses during forging, and subsequent machining. This weight of ingot is the maximum which can be handled with existing equipment in this country (and we think in the world) and can only be dealt with by two British forges. Furthermore, the metallurgical difficulties associated with the casting, cooling, and subsequent handling of such an enormous mass of alloy steel are very considerable indeed.

The variation in temperature throughout such a mass as it cools from casting heat will give rise to such stresses and cause such segregation of impurities that cracks may occur unless extreme care and very expert knowledge are exercised and used at every stage. Clearly and inevitably, the degree and extent of such segregated impurity in the subsequent forging will increase as the size of ingot increases. Such vessels, if made from a series of smaller forgings obtained from smaller ingots would necessitate several mechanical joints which, when of such dimensions, are extremely expensive.

There is, therefore, some technical justification for seeking methods, alternative to conventional forging, for the manufacture of really large pressure vessels.

Laminar Vessels for Ordinary Temperatures

General Principles of the Laminar Vessel Design.—The fundamental basis of the laminar vessel design is exceedingly simple and consists essentially in taking a centre tube of relatively light construction, placing light covers on each end, and then reinforcing the whole to withstand high internal pressure. The method of reinforcement must be such

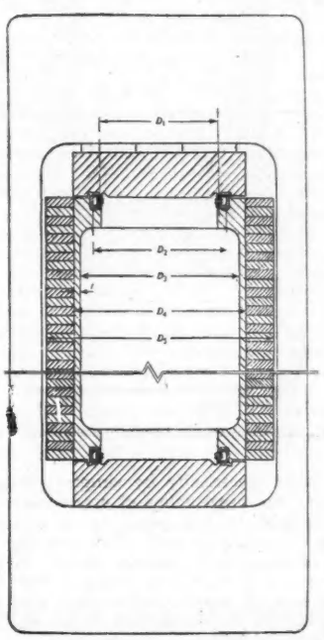


Fig. 3—*Main Design Details of Short Squat Vessel*

as to provide for both the hoop and longitudinal effects set up by the internal pressure. The hoop reinforcement required is obtained from well-fitting hoops surrounding the centre tube, while the longitudinal reinforcement is met by arranging a frame round the whole vessel, known as the portal frame. The hoops are cut from plate, while the portal frame is built up from plate; thus the whole of the vessel, with the exception of the covers, is constructed from plate. The covers are relatively simple forgings and even these could in some cases be made from rolled slab. Very large covers could if necessary be of built-up welded construction.

The main advantage therefore of the laminar design of vessel is that the raw material of construction is plate, which can be obtained from many sources throughout the country, *e.g.*, Tees-side, Lincolnshire, Scotland, South Wales.

* Institution of Mechanical Engineers, March 7th. Abstract.

† Imperial Chemical Industries, Ltd., Dyestuffs Division.

‡ Imperial Chemical Industries, Ltd., Billingham Division.

Fabrication also is relatively simple and well within the capacity of existing engineering shops which are reasonably well equipped. Experience in the manufacture of the two experimental vessels fully confirmed this.

Experimental Vessels.—Fig 1 shows a drawing of a 3ft diameter vessel designed for 350 atmospheres working pressure. The joints between the covers and centre tube are hollow rings designed to give special flexibility. This type of joint is not confined to vessels of laminar design, but has been used extensively on vessels of normal forging design. When under pressure it remains liquid or gastight by virtue of its self-tightening characteristics.

Prior to the application of pressure, however, it requires to be given a slight nip to form an initial joint seal. In vessels of normal design this is provided by tightening the cover or flange bolts, but in the laminar vessel the nip is obtained from the portal frame. An obvious method of doing this, and that chosen for the experimental vessels, was to warm

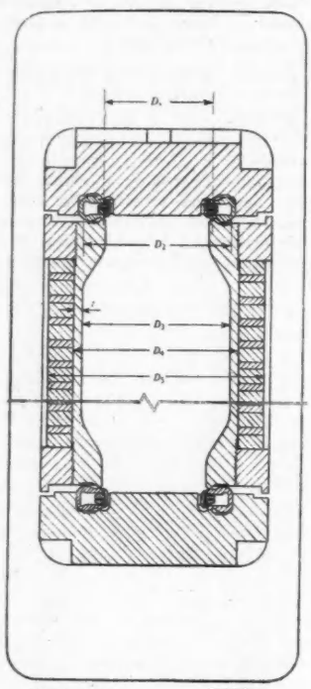


FIG. 4—*Main Design Details of Long Thin Vessel*

the frame electrically by simple heating elements; to insert shims of appropriate thickness between the frame and top cover, and then allow the frame to cool. The necessary thickness of shims to be inserted can be estimated closely. Although this method was chosen for the experimental vessels, other methods of securing the initial nip are available, as will be discussed later.

When the original decision was taken to fabricate two experimental vessels, the short 3ft diameter vessel of Fig. 1 was selected as a general case, but, in order to try the possibilities of this type of design, a more extreme case was selected also. This is shown in Fig. 2.

The proportions of this second vessel tended to make the laminar design less favourable in comparison with normal forging design. Its size was, however, governed chiefly by the necessity for limiting expenditure as far as possible consistent with the aim of obtaining adequate technical experience. Laminar vessels above the size selected would show to greater advantage in comparison with normal forging design.

Fabrication.—An outstanding advantage of the laminar construction is the straightforward procedure which can be adopted. In this connection it is noteworthy that the first o the two experimental vessels reached an advanced stage of construction only a few months after the original idea was put on paper, and no technical difficulty was met in either machining, welding, or assembly of the two vessels. This fact is remarkable when the difficulties associated with both forgings and the multi-layer type of vessel are considered. Defects in forgings can become visible for the first time when the vessels are nearly completed, and are liable to upset construction programmes. Each item of the laminar vessel is capable of being checked at almost every

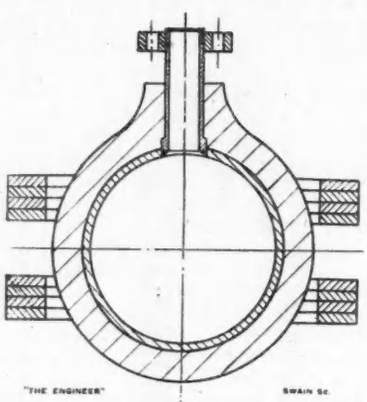


FIG. 5—*Possible Method of Making Side Connection in Laminar Vessel*

stage in the fabrication, and any defect could either be corrected immediately or else found out early enough to have very little effect on the final delivery of the vessel.

The portal frames of both vessels were built up from plates from which the inside portions had been machined away. The machined-out plate was not entirely wasted as it contributed to the plate required for the reinforcing rings.

The possibility of utilising welding in the construction of the portal frames was considered, but was not adopted because it was desired to avoid any risk of distortion and misalignment of the built-up frames. It was obviously desirable to eliminate any such factor as this for experimental vessels. Actually no difficulty was experienced in securing satisfactory alignment of the portal frames, and there appears to be no objection to the use of welding in building up the portal frames of any subsequent vessels which may be constructed. This would lead to certain economies as well as removing the limitation on the length of a vessel of laminar construction. The overall length of the portal frame of the long, thin vessel (Fig. 2) was 48ft 6in. Longer vessels than this would therefore be possible, although an increase in diameter would in most cases be preferred.

Again, there is no limitation on diametral dimensions for practical requirements. Usually the size would be chosen so that the reinforcing rings could be machined from plate, which can be obtained in widths up to 9ft. If necessary, however, reinforcing rings with an outside diameter greater than 9ft could be made by means of welding. There is also the possibility of making the shrunk-on rings as forgings as, for example, in a tyre mill.

Cost.—Careful records were kept of the costs of the two vessels constructed, although it was scarcely to be expected for two reasons that these would reflect the economies to be gained by laminar construction. First, the vessels were prototypes and, as is inevitable in such cases, certain expenses must be incurred which would not r cur on succeeding types. Second, the sizes of vessel chosen for the prototypes were below the range of size where the laminar construction would show to greater advantage. Nevertheless, in spite of these disadvantages, it was found that the costs of the two vessels were no greater than the quoted costs of two equivalent forged vessels.

Design Details.—Each of the two experimental vessels was designed for a working pressure of 350 atmospheres, and a test pressure of 525 atmospheres ($1\frac{1}{2}\times$ working pressure) was considered appropriate. The main dimensions and the values of the calculated stresses, both at the working and test pressures, are given in Figs. 3 and 4, and Tables I and II. The method whereby the longitudinal stresses are derived is given. The method of obtaining the hoop stresses cannot be given so simply, however, because they depend not only upon the internal pressure, but also upon the shrinkage adopted when securing the rings on to the centre tubes.

A relatively light shrinkage was chosen for this operation on each vessel of approximately 0·0003in per inch diameter of cylindrical surface common to both tube and rings. The resulting interface pressures were calculated to be between 0·2 and 0·3 tons per square inch. This interface pressure is, of course, increased on the application of internal pressure. These factors were taken into account in determining the hoop stress values given.

Tests of Vessels Prior to Service.—The tests carried out on the vessels prior to service consisted of the following:—

(*a*) Shim tests, *i.e.*, tests to determine the appropriate thickness of shims to insert for the purpose of obtaining the initial nip on the joints.

(*b*) Pressure tests to 525 atmospheres.

Extensive strain measurements of the vessels were made in these tests in such a manner that they could readily be correlated with each other. The measurements included those of longitudinal strains of both portal frame and centre tube by means of suitable extensometers, and of strains at the joints, from the gaps between the covers and flanges. The volumetric strains of the vessels under pressure were also determined from measurements of

TABLE I.—*Design Data for Short Squat Vessel*

Linear dimensions.		Areas.			Materials and stresses.				
Item in Fig. 3.	Inches.		Formula.	Square inch.	Nature of stress.	Part of vessel.	Material.	Stress, tons per square inch.	
								350 atmos.	525 atmos.
D_1	27	A_1	$\frac{\pi}{4}D_1^2$	573	Longitudinal	Centre tube $\frac{P(A_3-\frac{1}{2}A_2)}{A_4}$	Mild steel	5·8	8·7
D_2	31	A_2	$\frac{\pi}{4}(D_2^2-D_1^2)$	182		Portal frame $\frac{P(A_1+\frac{1}{2}A_2)}{A_3}$	1·0-1·5 per cent manganese steel	6·4	9·5
D_3	36·59	A_3	$\frac{\pi}{4}(D_3^2-D_1^2)$	478					
D_4	39·16	A_4	Centre tube $\frac{\pi}{4}(D_4^2-D_3^2)$	152·7	Hoop	Centre tube	Mild steel	3·1	6·4
						Rings	1·0-1·5 per cent manganese steel	7·3	10·5
D_5	51·5	A_5	Portal frame cross section	240					
t	1·285								

the amount of water pumped into them; due allowance was made for the compressibility of water. All the pressure tests of the vessels as originally designed were carried out at room temperature.

The main results obtained from these tests and deductions of interest are as follows:—

(a) *Shim Tests.*—Details of the results of these tests are given in Table III.

The magnitudes of these, and also other shim interferences tried, were found to be consistent with the relative elongations and contractions of the portal frame and centre tube under the initial nip loads, provided due allowance was made for such strains as those resulting from:—

(i) Compression of the shim packs, which included compressed asbestos fibre packing material in order to distribute the load evenly between the portal frame and covers.

(ii) Deflection of covers and beam ends of portal frame.

(iii) Compressive strain at the various bearing surfaces, particularly those at the hollow joint rings where the bearing pressures are high.

(b) *Pressure Tests.*—From the strain measurements taken during the pressure tests it is possible to deduce the longitudinal stresses induced by internal pressure in both portal frame and centre tube. It was found that the stresses deduced from the strain measurements agreed reasonably well with those of Figs. 3 and 4, obtained by calculation. No strain measurements were made whereby the calculated hoop stresses could be checked, but this was considered unnecessary in view of the generally accepted Lamé method for their determination.

TABLE II.—*Design Data for Long Thin Vessel*

Linear dimensions.		Areas.			Materials and stresses.				
								Stress, tons per square inch.	
Item in Fig. 4.	Inches.		Formula.	Square inch.	Nature of stress.	Part of vessel.	Material.	350 atmos.	525 atmos.
D_1	15·5	A_1	$\frac{\pi}{4}D_1^2$	189	Longitudinal	Centre tube $\frac{P(A_2-\frac{1}{2}A_2)}{A_4}$	Mild steel	2·25	3·4
D_2	21	A_2	$\frac{\pi}{4}(D_2^2-D_1^2)$	157		Portal frame $\frac{P(A_1+\frac{1}{2}A_2)}{A_5}$	1·0-1·5 per cent manganese steel	6·8	10·3
D_3	20·875	A_3	$\frac{\pi}{4}(D_3^2-D_1^2)$	153					
D_4	23·075	A_4	Centre tube	76	Hoop	Centre tube	Mild steel	2·6	5·5
			$\frac{\pi}{4}(D_4^2-D_3^2)$			Rings	1·0-1·5 per cent manganese steel	6·7	9·6
D_5	30·5	A_5	Portal frame cross-section	90					
t	1·1								

TABLE III.—*Results of Shim Tests*

	Short squat vessel, Fig. 1.	Long thin vessel, Fig. 2.
Shim interference chosen, inches	0·1	0·35
Initial nip obtained, tons ...	500	275
Joint bearing pressure given by initial nip, tons per square inch...	25·6	22·5

The volumetric strain was found to vary linearly with the pressure, and no significant permanent volumetric strain was recorded.

Hydraulic pressure was the means adopted for applying internal pressure up to the test figure. In each case, after the test pressure had been applied, a quantity of water was released from the vessel, and high-pressure nitrogen introduced into the gas space until a pressure of 350 atmospheres was reached. By this means the gas tightness of the top joints was established.

Experience with Vessels in Service.—The earliest opportunity was taken to put each of the vessels into plant service. The short squat vessel was put into service as a catchpot in an oil works hydrogenation plant. The working conditions under which it operates are:—Pressure, 300–320 atmospheres; temperature, slightly above atmospheric (40 deg. Cent., 104 deg. Fah.). It has been in continuous service for approximately 1½ years, during which time it has given satisfactory performance, judged by the fact that no maintenance work of any kind has been required. There has been no occasion to open up the vessel for internal examination.

The long thin vessel was put into service as a carbon monoxide removal tower in an ammonia works, where it operates under a working pressure of 350 atmospheres and at atmospheric temperature. It has been in continuous service for approximately two years. In this case, also, no maintenance work or opening up for examination has been required.

Special Design of Laminar Vessel.—The modification to the original design of long thin vessel, to enable it to withstand temperature fluctuations between portal frame and centre tube, consisted of the replacement of the original top cover by a cover containing four pistons.

Future Developments of the Laminar Type of Construction

Application.—As already mentioned in the paper, one of the most outstanding features of the experimental laminar vessels was the ease with which they were constructed and the absence of special equipment required. During the brief period of development of the design—which altogether did not exceed about six months—possibilities in a number of directions became apparent. These include temperature working, the use of special materials and the possibility of a composite vessel being constructed with facings or linings of special metals reinforced by ordinary steel. Great confidence can be expressed in the ability of the design to meet new applications.

One of the criticisms directed against the laminar form of construction is that no provision is made for making side connections into the vessel. In the case of a thick-walled high-pressure forging this is done by boring through the wall and making a joint usually held by means of studs screwed into the wall of the vessel. No allowance is made for the weakening effect of the hole and the metal removed at the screwed stud holes.

The authors are of the opinion that side connections in the body of a high-pressure vessel should be avoided and taken through the end covers, if possible. Nevertheless, side connections in the body are occasionally required, for special reasons, and it must be admitted that, in spite of theoretical qualms, the side connections in thick-walled forgings have been found satisfactory from the practical point of view. Some means of making a side connection in a laminar vessel is therefore desirable, and a possible method is shown in Fig. 5. This method utilises a small ring forging in place of a number of the reinforcing rings. The other features of the method are thought to be self-explanatory. The weakening effect of the hole in the vessel may be fully compensated in this way without any element of uncertainty.

Automatic Control of Synchronous Clocks

THE likelihood that mains frequency variations may persist for some years gives topical interest to a new form of control that is now available for maintaining the accuracy normally associated with electric synchronous clocks. This control system, which has been developed by Jackson Automatic Electric Controls, Ltd., Windsor House, Victoria Street, London, S.W.1, replaces grid frequency control at the control room by frequency control in the consumers' premises. The new system will appeal, therefore, to those public services and industrial and commercial users whose needs cannot be met by the present method of overcompensating for daily low frequency by higher frequency during the night.

Fundamentally, the control system consists of four parts: (*a*) a frequency or time control unit, (*b*) an amplifier supplying the various clocks at 50 cycles per second, (*c*) a synchronous electric clock driven from this output and a mechanical reference clock to provide a suitable standard against which the output can be compared, and (*d*) suitable control of the amplifier so that the time of the driven clock or clocks can be corrected.

The time control consists of a precision crystal unit operating at 100kc/s through a very stable dividing circuit, giving, through four stages a reference output of 50c/s. Temperature control of the circuit is eliminated, and the accuracy of the output is better than 1 part in 100,000, corresponding to an error of 1 second in 27·8 hours. The 50c/s output signal is amplified in a mains-driven, four-stage amplifier, the output of which is at 200V to 250V. For controlling respectively ten and twenty clocks of average load, including the electrical reference clock, the unit is supplied alternatively in 15-W and 30-W capacities.

An accuracy of the order of two seconds per week is required of the mechanical clock, which is of the ship's chronometer class. This instrument consists of an eight-day spring-driven, 6in dial unit, while the electric synchronous clock is of the same diameter. Both of these clocks have centre second hands, and for convenience both are mounted together with the master control unit in a single enclosure. A second enclosure houses the amplifier with its adjusting dial whereby the time registered by the driven clocks can be corrected.

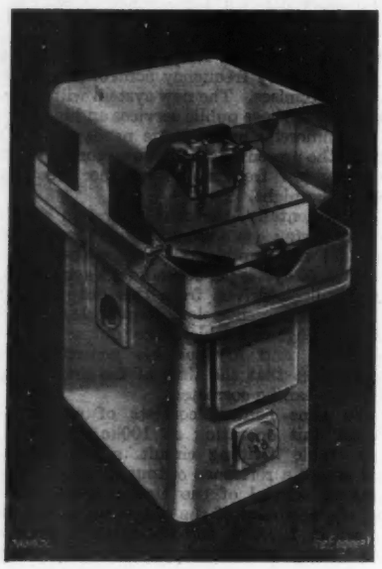
Since the equipment produces an uninterrupted and progressive motion it is suitable for driving synchronous recorders. It can be used to operate a series of timers which are being developed, we understand, by the same company to take the place of time switches for process timing, programme control, lighting and heating control and similar duties. It is stated also that facilities can be provided to make the clock control system independent of the contingency of mains supply voltage failure.

A Carbide Tool Sharpening Machine

WE have received particulars of a new grinding and lapping machine for shank type carbide cutting tools which has just been introduced by A. C. Wickman, Ltd., of Coventry. It is a self-contained unit with two 8in diameter wheels and having its tables set at a convenient working height above floor level. The wheel covers fitted to the machine, together with a special outer splash screen and the tray, are designed to prevent any coolant splashing out during the grinding of a tool. Rubber flaps which form part of the screen are fixed at the top edge only and can be pushed back by the operator when grinding cranked tools.

The tool rests are carried on leaf springs and forward movement to compensate for wheel wear is effected by turning a knob at the front of each table. Each tool rest is 25in wide by 10in deep in front of the wheel, and its surface is extended to a depth of 7½in by 8in wide behind and on each side of the wheel. This area provides ample side space for the grinding

of cranked tools, and a tenon slot is cut in the slides 4¾in back from the wheel face. These rests are sufficiently large to accommodate all tools with shanks up to 2in square, and they swivel on a horizontal axis in line with the wheel face so that a constant level can be maintained at the wheel for all grinding operations. Each rest is adjusted by means of a clamping lever with reference to a protractor scale, and can be quickly and rigidly set to any desired angle between 10 deg. negative and 15 deg. positive.



CARBIDE TOOL GRINDING AND LAPPING MACHINE

The wheel spindle is driven by a 2 h.p., 2910 r.p.m. reversible motor giving wheel speeds of 6100ft per minute at the periphery and permitting grinding on either side of the wheels. Stop and start buttons and reversing switch are handily placed at the side of the machine. The motor spindle is designed to accommodate 1¼in bore diamond wheels, and 2in bore grinding wheels by the use of an adaptor, so that either end of the machine can be used for grinding or lapping. Wheel covers of cast aluminium can be quickly removed for wheel charging purposes, or adjusted to conform with wheel wear by the release of one clamping lever.

The cleaning of the machine and sludge removal are simplified by having the coolant tank in the form of a tray which can be pulled out from the base. This tank has a capacity of 8 gallons and is connected to the splash tray by a pipe large enough to prevent clogging. The coolant is circulated by a pump driven by an independent motor situated at the bottom of the machine.

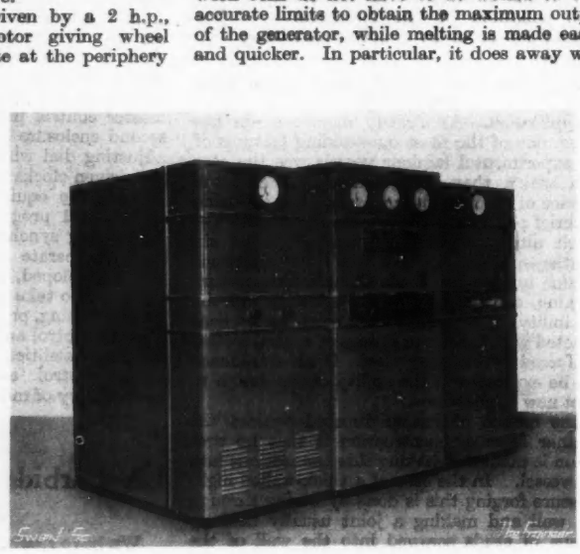
Radio-Frequency Induction Heating Generator

MANY heat-treatment operations and processes have hitherto remained outside the scope of radio-frequency induction heating, because the power required has been beyond the capacity of existing valve driven plant. To reduce this limitation Philips Lamps, Ltd., Century House, Shaftesbury Avenue, London, W.C.2, has developed and is manufacturing a new radio-frequency equipment—the F.V.100 generator, which will produce up to 54kW measured in the work (rated output 50kW). With this generator it is claimed that true skin heating as opposed to skin hardening can be achieved on areas of 7 to 10 square inches. Thus there is brought within the scope of induction heating a very large number of components which cannot be treated progressively and in which "single-shot" treatment with lower powers results in heating to such a depth that the mechanical properties of the material are impaired.

The range of work possible is as wide as that handled by the smaller generators now in use, but the size of specimen may be larger or the number greater. For example, ¾in diameter steel bar hardened to 0·030in at 2 to 2½ feet per minute with 20kW can be hardened with 50kW at a speed approaching 8 feet per minute, or where 20kW will melt 10 lb of steel in ten minutes, 50kW will melt 25 lb to 30 lb in the same time.

The generator has been designed for flexibility to cope with the variety of work it has to perform. In addition to the main frequency of 350 kc/s radio-frequency current is available at 400, 700 and 1000 kc/s, the frequency being selected by an off-load link system. The main purpose of the additional frequencies is to provide large steps in the output current so that widely different loads can be matched to the generator. By this means, the full power output of the generator is available in masses of metal whose volume varies as widely as from, say, 1/10th cubic inch to a cubic foot.

One of the most prominent characteristics of the generator is the on-load continuous variation of output current. The ratio is approximately 2 : 1, which gives a variation of 4 : 1 in the power in the work. This is a factor of considerable importance, for it means that work coils do not have to be wound to very accurate limits to obtain the maximum output of the generator, while melting is made easier and quicker. In particular, it does away with a lot of tedious preparation in carrying out pre-production experimental work. This on-load variation is obtained by inserting a variable step-down radio-frequency transformer between the valve anode and tank of the Colpitts circuit; an advantage of this transformer is that it is almost loss-free.



RADIO-FREQUENCY INDUCTION HEATER

All controls have been grouped on the front of the generator, as illustrated herewith, so that the work is visible from the controls. Remote control is provided for, using a push-button station or foot switch. All meters have 6in dials for easy reading. An accurate electronic timer, range 0·2 to 10 seconds, is built in as a standard feature. Special attention has been given to safety devices. High-voltage components are oil-immersed and natural air cooling has been relied on for all components with the exception of the rectifier valves. The circuits are interlocked to ensure correct switching sequence, and water flow switches and time delays protect the valves. Overload trips which bring out the contactors in three cycles (0·06 seconds) are provided in valve filament, valve anode, and h.t. transformer primary circuits. In addition to these overloads Siemens h.r.c. fuses are used throughout for auxiliary and main circuit protection. The main circuit breaker, which has normal overload releases, is interlocked with the two rear doors for the safety of personnel. An approved type of interference suppressor is connected in the incoming mains supply.

Servicing and maintenance have been carefully considered in arranging the general layout of the components, all of which are accessible from the two rear doors and the internal gangway. The standard model is suitable for mains voltages of 380V to 440V, three-phase, 50 cycles, and its maximum input is 93·5kW at a power factor of approximately 0·9.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

SOCKETS FOR WIRE ROPES FOR GENERAL ENGINEERING PURPOSES

No. 463 : 1946. This revised standard, first published in 1932, incorporates an existing amendment and corrects dimensions in Tables I and II. There is a modification to the second paragraph of the foreword limiting the use of the sockets to white metal capping, pointing out the sockets are not suitable for use where the rope is held by means of a cone formed by bending back the wires of the rope. Appendix A is now identical with B.S. 643, Capping Metal for Wire Ropes, Appendix B, with an additional footnote. The text, figures and tables have been rearranged. The standard deals with both "open" and "closed" sockets for wire ropes from ¼in to 5in circumference and provides for workmanship, tolerances, heat treatment and proof testing, while the appendix gives a recommended method of socketing with white metal to B.S. 643.

THE TESTING OF PLASTIC MOULDINGS

No. 1330 : 1946. Some years before the War, a comprehensive survey was made by a Committee of the British Standards Institution of the various kinds of specifications dealing with the properties of moulded insulation which the electrical engineering industry required. The needs were found to fall into three divisions :—

(*a*) Specifications fixing the minimum requirements of moulding insulating materials for various kinds of application.

(*b*) Specifications of the properties of the various broad classes of moulded materials.

(*c*) Methods of tests which could be applied to finished industrial mouldings.

Various committees of the B.S.I., the British Plastics Federation, and the Electrical Research Association, have been at work on these different branches of the work, and in category (*a*) two specifications have already been published, namely, B.S. 771 : 1938 and B.S. 1322 : 1946, dealing with phenolic moulding materials and mouldings of the phenolic and aminoplastic types, respectively. In category (*b*) a specification (B.S. 488) for materials for general electrical accessories was issued some years ago, and is under revision, and further specifications of a similar kind are in preparation. As regards tests on finished mouldings, it was realised that proof tests on complete mouldings will always be needed for the acceptance of such products. But it was considered that the development of a technique for cutting miniature test specimens from the complete moulding, and of the development of suitable tests, electrical, physical and mechanical, on such miniature specimens was necessary as a means of effecting control over their production.

The British Electrical and Allied Industries Research Association was therefore asked to investigate the problem of the development of suitable test technique. A report, ref. B/T 40, was prepared by the E.R.A., and this has now been published by the B.S.I. as an Interim Report on Suggested Methods of Testing Finished Mouldings, B.S. 1330 : 1946. It is hoped that this report will enable the electrical and plastics industries to obtain experience in the technique of the preparation of miniature test samples and of the various methods of test recommended, so that standard tests suitable for inclusion in specifications can, in due course, be evolved. Price 7s. 6d., post free.

Continental Engineering News

Scheldt Tunnels

A new tunnel under the Scheldt is being built at present at Antwerp. Before the war there were two separate tunnels under the river, for vehicles and pedestrians, linking the city of Antwerp and the borough of St. Ann, on the left shore of the river. These tunnels were driven between 1930 and 1933 by the Franki Company for the Société Intercommunale de la Rive gauche d'Escaut. The vehicular tunnel is 6920ft long, accommodating a roadway 22ft wide to carry two lines of traffic, flanked by a service sidewalk; the headroom is 14ft 8in. The tunnel is lined with cast iron rings of 30ft 10in internal diameter, finished with concrete and glazed tiles. Special precautions were taken in order to make the tunnel water-tight. The tunnel for pedestrians has an internal diameter of 14ft. It is equipped with escalators. Both tunnels are well lit and ventilated. These two tunnels were heavily damaged in 1940 and 1944. Now repair works are completed and the tunnels are again available for traffic. To meet the growing demands of the pedestrian traffic the authorities concerned decided to build a third tunnel, for pedestrians. Preliminary works at St. Ann started recently and are progressing rapidly.

Belgian Railway Electrification

It was recently announced that the Belgian National Railways have approved large-scale plans for the extension of electrification. The new proposals are divided into ten stages, which will be completed within five years. At present most of the trains between Brussels and Antwerp are worked electrically. The first route to be electrified under the new scheme is to be Brussels-Charleroi. This work, which will be completed by 1949, will greatly improve railway communications between the industrial area of Charleroi and the port of Antwerp. Later, the following routes will be electrified:—Brussels-Namur, Brussels-Ostend (it is expected that this work will be completed before January 1, 1950), Brussels-Liége, Ghent-Schellebelle-Muizen, Monceau-Merelbeke, linking the industrial basin of Charleroi with the port of Ghent, and Mons-Charleroi. These proposals involve the further conversion to electric traction of 937 route miles and will necessitate the use of 120,000 tons of steel, 21,000 tons of copper, 165,000 tons of cement, 30,000 cubic yards of timber, 320,000 cubic yards of sand, 650,000 cubic yards of ballast, 30 millions of bricks, &c. Expenditure on the new scheme is estimated to be in the neighbourhood of 13,500 millions of Belgian francs (about £7·5 millions).

Danish Railway Centenary

The centenary of the creation of the Danish State Railways (D.S.B.) was celebrated last month. The first railway line linking Copenhagen with Roskilde was opened by King Christian VIII on June 26, 1847. It was 19½ miles long. It is of interest to note that the D.S.B. now have 1500 miles of railway lines and 1900 miles of bus lines. The rolling stock owned by the railways includes 591 locomotives, 168 railcars, 15,868 wagons and 189 buses. There are many notable engineering structures spanning Danish wide straits. Amongst them, the more remarkable are the bridge over the Little Belt and the Storstrom bridge. The former is a steel lattice girder bridge, 2720ft long. It is composed of five main spans, flanked on both sides by concrete approach viaducts. The Storstrom bridge, built by a British firm (Dorman, Long and Co., Ltd.), carries both road and railway across the wide strait dividing the islands of Zeeland and Falster. This fine bridge is 10,535ft long, the navigation span being 447ft 5in long.

Polish Iron and Steel Industry

Despite grave difficulties encountered through war damage (estimated at £12½ millions), the Polish iron and steel industry is making good progress towards reaching the pre-war level. In 1946 Poland produced 728,000 tons of pig iron and 1,204,000 tons of steel, while in 1938 the figures were respectively 900,000 tons and 1,600,000 tons. By now, all iron and steel plants in the country are nationalised under the management of the Central Iron and Steel Board at Kattowice. The production schedule for 1949 envisages a total output of 1,300,000 tons of pig iron and 2,000,000 tons of steel. This programme, however, may be hindered by insufficient raw material supplies, especially iron ore.

Dutch Harbour Activity

In September, 1944, the port installations of Rotterdam and Amsterdam were blown up. The damage to these ports amounted to 140 million florins (£13 millions) for Rotterdam and 19·2 million florins (£1·8 millions) for Amsterdam. Repair works started soon after the liberation and advanced satisfactorily. The situation in these main Dutch ports is now as follows:—

	Rotterdam.			Amsterdam.		
	1940.	1945.	1947.	1940.	1945.	1947.
Quays for sea vessels, miles	12·0	7·0	7·5	9·6	4·0	7·5
Quays for inland ships, miles	10·5	6·8	6·8	8·9	7·1	8·3
Quay cranes	282	159	172	357	93	137
Floating cranes	80	45	65	43	20	31
Warehouses, per cent	100	60	65	100	80	95

In 1946, 4464 ships with a capacity of 5,911,539 tons arrived in Rotterdam, and 1706 ships with a capacity of 1,817,922 tons in Amsterdam. For 1938 these figures were respectively 15,336 ships (24,744,472 tons) and 3464 ships (4,664,049 tons). Since 1946 shipping traffic in both ports shows an increasing tendency. The largest lock in the world, the Ijmuiden lock, situated in the port of Amsterdam, was damaged during the war. Now the structure is entirely restored and Amsterdam is able again to receive large ocean-going vessels.

Kloten Airport, Switzerland

Works are now in progress in the Zurich Canton for the construction of the inter-Continental airport at Kloten. The decision to build the airport was taken in May, 1946, after a favourable vote of the Zurich electorate. Works, whose cost is estimated at 59½ million Swiss francs (about £3,400,000), will be completed within three years. The area selected has a surface of 1600 acres. By June, 1946, plans were completed for an airfield with four runways, having lengths of 2100 yards, 2900 yards, 1700 yards and 1700 yards, and being respectively the main, night landing and two secondary runways. The width of the runways is to be 70 yards, 83 yards, 50 yards and 50 yards respectively. These runways will be built of concrete, bordered by grass strips, 16½ yards wide each. The equipment used on the contract comprises 20 scrapers, 30 locomotives, 350 wagons with 1½ cubic yards to 4 cubic yards capacity, 19 miles of narrow-gauge tracks, 25 dumpers, 6 bulldozers, 15 steam rollers, as well as many lorries and various other machinery. The average number of men employed will be about 1200, and the quantities of materials to be used on the contract include 1,000,000 cubic yards of earthwork, 200,000 cubic yards of timber shuttering for concrete runways, 160,000 cubic yards of concrete. The terminal building will be constructed later.

Exploration of Ocean Bottom

Professor August Piccard, well known for his stratospheric flights, is preparing for an expedition to study the bottom of the Atlantic Ocean, in company with Professor Max Cosyns, of the University of Brussels. A special ocean balloon, called "Bathyscaph," will be used. The "Bathyscaph" is composed of a steel shell, 23ft long and 10ft wide, containing seven aluminium reservoirs filled with a special gas (lighter than water). This shell will operate as a submarine and will carry the explorers' car, in which the two scientists will live and work. The car is a high-tensile steel sphere, 3¾in thick, with a diameter of 6ft 6in. It is designed to withstand a pressure of 24,000 tons. The interior is equipped with two powerful searchlights of 5000 candle-power each (there are two light ports in the sphere). The descent will take place in the Gulf of Guinea and the explorers expect to reach depths up to 20,000ft. The expedition will be accompanied by the Belgian steamer "Scaldis," 4000 tons, which will carry the "Bathyscaph" to the site.

The Palace of Soviets, Moscow

In 1938, the Government of U.S.S.R. started the construction of a large building for the civil services of the Union. The new Palace of Soviets, which will be 1400ft high, exceeding thus the height of the famous Empire State Building in New York, will, it is claimed, be the tallest building in the world. At the top there is to be a gigantic statue of Lenin, 330ft high. The main framework of the palace will be composed of five steel drums, each drum consisting of thirty-two outer and thirty-two inner pillars interconnected by radial and tangential girders. Special high-tensile alloy steel, with an ultimate tensile strength of 34 to 40 tons per square inch, is being used for the framework. The statue of Lenin will be of stainless steel. In 1941, at the moment of the German attack, foundations were completed and the erection of the main framework was commenced. During the siege of Moscow, however, steel members of the framework were dismantled to meet war needs. Now works, resumed after V-day, are advancing satisfactorily. The complex system forming the main framework posed designers many difficult problems. These problems have been investigated in research laboratories, where stability tests on scale models were carried out by leading Soviet scientists.

Soviet Railways' Five-Year Plan

Last year, the Supreme Soviet of U.S.S.R. approved a five-year scheme for development and modernisation of the railway network of the Union. The cost of the plan is estimated at 26,700 million roubles. Expenditure is divided under the following headings (in millions of roubles):—New constructions, 7332; doubling existing tracks, 3490; bridges and permanent way, 6150; electrification, 1285; management, 1900; locomotives, 1640; wagons, 367; design and insurance, 775; staff dwellings, 2450; workshops, 1311. There will be 4500 miles of new tracks, of which the major part will be situated in Southern Siberia, between Kuybishev and Magnitogorsk. The new Southern Siberia Railway will be 2500 miles long and will have sixty-six stations and 137 crossings. Three tunnels will be built on this line, the longest being 7650ft from portal to portal. Other railway lines will be constructed in the Urals, Central Asia, the Caucasus and the northern part of European Russia. Electrification will be applied to 3300 miles of new lines, the total figure amounting thus in 1950 to 4750 miles. The Central Asia and Caspian Sea lines will be provided with 865 diesel locomotives, while 550 new electric locomotives will be put into service. About 1800 long and medium-span bridges will be erected throughout the Union and twenty-two workshops for locomotives and wagons will be added to those existing in the country.

Sino-British Civil Aviation Agreement.—Britain and China have signed a civil aviation treaty, to last for four years, which opens airports in the United Kingdom and British territories overseas to Chinese aircraft, and landing areas and water bases in China to British aircraft. The agreement stipulates that seven airlines are to be operated by each nation.

Industrial and Labour Notes

The T.U.C. and the Economic Crisis

The general council of the Trades Union Congress held a special meeting on Wednesday of last week to consider certain factors relating to the world economic situation. According to an official statement, the council registered its full conviction that "the tremendous impact of this situation on Britain is so serious as to present a dire threat to the standard of life of all our people." In the light of the facts presented, the general council urges all trade unionists and people generally to appreciate the serious nature of the problems.

The general council expressed at its meeting approval of the reintroduction of a Control of Engagement Order, and, as a first step, directed attention to the primary need for transference of labour from unessential and non-productive employment to those industries which are vital to the country's economic stability. It if should be found that the application of a Control of Engagement Order does not produce the results required, the general council stated that it would be prepared to discuss with the Government further measures, including direction of labour.

With regard to working hours, the general council recommended that consultation should take place with the specific industries involved, with a view to examining how far an extension of hours was imperative to contribute to the increased production necessary for expanding exports.

The National Joint Advisory Council

The National Joint Advisory Council, representing the British Employers' Confederation and the Trades Union Congress, also held a meeting on Wednesday of last week. The Minister of Labour presided.

First of all, the council discussed the terms and conditions under which the hours provisions of the Factories Act should be relaxed in order to facilitate the staggering of working hours for spreading the electricity load. The later stages of the meeting were devoted to consideration of the Government's proposals for dealing with the present economic situation. A full statement of the proposals was made to the Council by the Minister of Labour, and is understood to have been along the lines followed by the Prime Minister in his speech in the House of Commons on the same day.

The Council discussed the proposals, giving particular attention to the control of engagement and the lengthening of working hours, and then passed a resolution pledging full co-operation in assisting to restore the country's economic security. The resolution indicated that arrangements would be made for the National Joint Advisory Council and its Joint Consultative Committee to consider the detailed application of the proposals. For this purpose a meeting of the Joint Consultative Committee was held on Wednesday of this week, but at the time of going to press no details of its proceedings are available.

I. L. O. Industrial Committees

The governing body of the International Labour Office has set up seven international committees to deal with conditions in major industries. The industries covered include inland transport, textiles, coal mining, iron and steel production, the metal trades, petroleum production and refining, and building, civil engineering and public works, and the committees are of a tripartite character consisting of representatives of the Governments, employers and workers of the countries most directly concerned with the respective industries. The general terms of reference of each committee are to consider the present social problems of its industry and future international co-operation on social policy and its economic foundations in the industry. The committees are authorised to recommend action on the part of the employers' and workers' organisations concerned in the various countries, as well as to recommend action by the I.L.O. Two of the committees—the iron and steel and the metal trades—are to meet in Stockholm on August 20th and September 2nd, respectively.

Industrial Accident Prevention

The Royal Society for the Prevention of Accidents, which celebrates its silver jubilee this year, is organising a National Safety Congress, which is to be held in Brighton from October 6th to 10th. On three of the days, October 7th, 8th and 9th, there are to be special industrial sessions which will provide opportunity for the discussion of various aspects of industrial accident prevention.

Amongst the papers to be presented at these industrial sessions are two on safety methods in American factories. They will be given by Mr. L. N. Duguid, H.M. Superintending Inspector of Factories, and Mr. R. E. Tugman, of Imperial Chemical Industries, Ltd., both of whom have recently visited the U.S.A. Other subjects with which the conference will deal are the training of supervisors in safety methods, noise abatement in industry, floor surfaces and the falling accident, and the guarding of milling machines.

Full particulars of the conference can be obtained from Royal Society for the Prevention of Accidents, 131, Sloane Street, London, S.W.1.

Changes in Working Hours

According to the *Ministry of Labour Gazette*, the changes in hours of labour reported to have come into operation in the month of June, resulted in an average reduction of approximately 3½ hours a week for about 260,000 workpeople.

The principal industries or services affected were company-owned omnibus undertakings and the road transport section of London Transport, where the normal working week was reduced from forty-eight or forty-seven to forty-four hours; the road vehicle repairing industry in which normal weekly working hours were reduced from forty-seven to forty-four; a section of the heavy chemical industry, in which dayworkers' hours were reduced from forty-seven to forty-four a week, and shift-workers' hours from forty-eight to forty-four; a section of the chemical fertiliser industry in which the reduction was from forty-eight or forty-seven to forty-four hours a week; and holloware manufacture, in which industry the normal weekly hours beyond which overtime rates become payable were reduced from forty-seven to forty-four.

In the first six months of this year, changes in hours of labour, reported to have come into operation in the industries covered by the Ministry of Labour's statistics, resulted in an average reduction of about 3½ hours a week for approximately 3,640,000 workpeople.

Employment and Unemployment

The monthly statistics concerning employment and unemployment in Great Britain were issued on Tuesday evening last by the Ministry of Labour. They show that the total working population of the country in June—excluding those in domestic service—was 20,157,000, representing a decrease during the month of 13,000 (8000 men and 5000 women).

The total number of people employed in industry in June was 18,360,000 (12,754,000 men and 5,606,000 women), which was an increase of 62,000 on the total for May. This increase, it may be noted, included 10,000 women. Compared with mid-1939, the June figure indicates a net increase of 440,000 in the number employed in industry. Other figures show that there were 5,540,000 people engaged in manufacturing for the home market in June and 1,514,000 engaged in manufacturing for export.

The statistics regarding unemployment indicate that the number of people out of work continues to decline. On July 14th, insured people on the unemployment registers totalled 255,546, compared with 272,336 on June 16th, and 331,543 on May 12th. The July total was made up of 185,789 men, 4536 boys, 61,899 women and 3322 girls. It included 33,582 married women, many of whom have probably left industry, and 10,864 ex-Service personnel who had not taken up employment since being demobilised.

There were also on the unemployment registers, on July 14th, 11,324 uninsured people—there were 11,704 in this category a month previously—which figure included 1835 boys and girls under sixteen, who had not yet entered industry.

Increasing the Coal Output

The executive committee of the National Union of Mineworkers met on Thursday of last week to examine the suggestions put forward by the Government for increasing the country's coal output. It may be recalled that in his speech on the economic situation, the Prime Minister said that an average weekly output of 4,000,000 tons of deep-mined coal was the aim and that as an emergency measure it was suggested that the miners should work an extra half-hour a day.

It is reported that the executive of the union decided, after discussing this suggestion, to recommend to a special delegate conference of miners that the men should work two Saturday shifts each month instead of an extra half-hour daily. The union's recommendation must be agreed with the National Coal Board and discussions on the matter between the union and the Board began on Friday last. They were ultimately adjourned until Tuesday of this week.

The Shorter Working Week

In a statement accompanying the annual report of Guest, Keen and Nettlefolds, Ltd., the Chairman, Sir Samuel Beale, makes some comments on the effect of the five-day week in the company's works. He says that production would have been greater but for the introduction of the five-day week in January last. In some factories it may be possible by intensified effort to provide as much in forty-four hours as in forty-seven, but where automatic machinery is running at a high standard of efficiency, as in the case of the company's screw mills, a reduction in hours reduces output proportionately.

Sir Samuel's statement continues with the comment that, though output per man-week has thus been reduced, it is satisfactory to be able to report that output per man-hour has, in many instances, been increased by the introduction of new plant and better incentives. In no case, he observes, is the output per man-hour less than it was before the war, and the company is satisfied that it's employees, as a body, are working as hard as ever they did in the past.

Factory Projects in the London Area

A question put recently to the President of the Board of Trade sought information as to the number of new industrial projects and extensions agreed by the Regional Distribution of Industry Panels in the Greater London area in 1945, 1946 and 1947. A written reply states that during 1945 approval was given to seven new factory projects and to twenty-three extensions to existing factories, which, altogether, would provide additional employment for about 2580 people, when in full production; in 1945, approval was given to fifty-six new factory projects and 130 extensions, providing additional employment for approximately 10,780 people, when in full production; and in the first six months of this year twenty-three new factory projects and thirty-three extensions were approved, which would provide additional employment for about 3020 people, when in full production.

French Engineering News

(From our French Correspondent)

PARIS, August 8th

Monsieur F. Joliot-Curie, High Commissioner for Atomic Energy, in a recent conference with the French and foreign press, said that the fundamental results of French experiments were to be published, French scientists being against research secrets in the realm of nuclear physics. Unfortunately, he said, there was a "uranium curtain," the United States, Great Britain and Canada having monopolised uranium supplies following agreements signed during the war. For this reason, atomic energy development in France was dependent on the uranium found inside the country. At the conference, held sixteen months after the creation of the Comissariat for Atomic Energy, Monsieur Joliot-Curie outlined the present situation.

Only one year ago personnel employed by the Commissariat numbered less than one hundred. To-day there are over one thousand including specialists from industry and educational services, who undertake part time work, and workers who have been trained from among young science students. The Chatillon fort, which has been acquired by the Commissariat from the army, will be used for laboratories and the construction of detecting and prospecting apparatus. One of the instruments at present under construction is a uranium detector for use in France and the colonies. Uranium ore is treated at the Bouchet powder works, where it is washed and purified by an original process. In a few months it is hoped to produce a minimum of 100 kilos of pure metal a day.

Already research and prospection has revealed several important strata yielding enough uranium for the immediate needs of technical research prior to the construction of industrial plant. Two experimental plants for the study of chain reaction will be constructed at Saclay, south of Paris. These, stressed Monsieur Joliot-Curie, will not be used for dangerous experiments. One pile, using heavy water as a moderator and yielding 300kW to 1000kW, will be constructed at the end of 1948, while a more powerful pile, using graphite, and yielding 10,000kW, will be ready the following year. These piles will produce as many as possible of the radio-active elements which are a by-product of the atomic bomb, and which will be made available for the use of medicine, chemistry and nuclear science. It is expected that the first commercial atomic plant, with an output of 250,000kW, will be ready in about ten years.

Monsieur Curie deprecated the policy of the United States of making a secret of pure atomic research and the tendency to link atomic energy almost exclusively with bomb production. The French aim, he said, was to work for peaceful purposes and co-operation with other countries would be welcome. All discoveries would be made available for the widest possible use. Already the College de France laboratory had discovered and made public two new methods of splitting the uranium atom, resulting in fission into three and four elements instead of the two which suffice for the explosive reaction of the bomb.

* * *

The modernisation of the Lorraine coal mines is expected to yield excellent results because there are considerable reserves amounting to over 2 milliard tons, and seams are suitable for mechanisation.

The programme includes the sinking of nine new pits and the re-equipment of several others. Already there are 150 electric cutters in service, the most powerful being 50 h.p. machines capable of producing 300 tons in an eight-hour shift. The Lorraine basin will also be constituted so that 3-ton trams can be used (instead of 600kg to 800kg trams, as in the Nord-Pas-de-Calais), and mechanical loaders with a capacity of 2 tons per minute. At the moment 24,000 tons of rich coal are produced daily; the Monnet plan envisages a 41,000-ton daily output in 1950.

Notes and Memoranda

Rail and Road

NEW ESCALATOR AT BANK STATION, L.P.T.B.—A new escalator is to be opened at the end of this month at Bank Station on the Central Line of London's Underground. It is 103ft long and 51ft 6in deep and is sited between the two existing escalators. The new escalator is reversible and will run upwards during the morning peak period and downwards in the evening peak. The three pre-war escalators at Bank Station were all destroyed by a bomb in January, 1941. Two of them were replaced in 1941 and 1944 respectively.

THE CHEKIANG–KIANGSI RAILWAY.—According to *China Newsweek* reconstruction work is progressing rapidly on the Chekiang–Kiangsi Railway. The rehabilitation of this railway, which crosses Chekiang, Kiangsi and Hunan Provinces, began last February. By the middle of March the 67½ mile section between Kinhua and Chuki had been completed, and on June 5th the Pingsiang–Chuchow sector, which connects Kiangsi and Hunan, was opened to traffic. Ten days later, trains began to run between Nanchang and Kiukiang, a stretch of 80 miles. Three parts of the line are still unfinished—the Kinhua–Chuhsien section, the Shangjao–Nanchang section and the Nanchang–Pingsiang section, in all about 360 miles. Given sufficient material, reconstruction of the entire railway is expected to be completed towards the end of this year.

TYRE PRICES.—The Tyre Manufacturers' Conference says that it is being asked from several quarters whether the fall in the cost of rubber is likely to have any effect upon the price of tyres. It points out in reply that less than half the weight of a car tyre is in natural rubber, the price of which is much what it was in 1939, but that the higher wages of the men and women who make tyres have, alone, more than doubled the cost—the increase is 139 per cent for a popular size of car tyre and 135 per cent for a typical truck-size giant tyre. The wages of the operatives who turn cotton into tyre casings have also doubled. The cotton itself costs more than thrice what it did and the rayon which is taking the place of cotton for larger sized tyres costs 185 per cent more than the cotton previously used. Imported cotton tyre cord is as much as 272 per cent dearer than before the war. Of the other ingredients of a tyre, carbon black has gone up 154 per cent, steel wire for tyre beads, 40 per cent, and chemicals used for mixing the rubber, such as sulphur, pine tar, zinc oxide and stearic acid, are anything from two to five times the price they were before the war. While, therefore, it is not possible at the moment to say what a tyre will cost twelve months hence, there is no certainty that it will be cheaper.

Air and Water

ROUND THE WORLD SOLO FLIGHT.—On Sunday last, August 10th, Captain W. P. Odom landed at Chicago Airport having completed a solo flight round the world in 73 h. 5 min. The flight was made in a Reynolds "Bombshell" aircraft and the distance covered was approximately 20,000 miles. The previous record, which Captain Odom, has now broken, was set up by Mr. Wiley Post, who in 1933 flew a distance of 15,596 miles in 187 hours.

NEW SOUTH AFRICAN AIR SERVICE.—As a result of the air agreement recently concluded between the South African and Dutch Governments, K.L.M. is opening a regular weekly air service to Johannesburg. Since October, 1946, K.L.M. has been operating special flights to South Africa with "DC-4" aircraft, by way of Algiers, Kano and Leopoldville, the journey of some 6500 miles being completed in two days. It is expected that when "Constellation" aircraft are brought into service on this route in the very near future, the flying times will be cut considerably.

IT is with deep regret that we learn of the death at Cape Town on Saturday, July 26th, of Mr. A. W. Gillespie, the Commodore Chief Engineer of the Union-Castle Mail Steamship Company, Ltd. Mr. Gillespie, who was sixty-two years of age, was appointed Commodore Chief Engineer only last June, on the retirement of Mr. W. E. Tidman. He joined the company in 1906 and became chief engineer of the "Athlone Castle" in 1941. In 1944 he was appointed to the "Cape Town Castle," in which he continued to serve until his death. He was taken ill on the voyage between Port Elizabeth and Cape Town, and on docking he was removed to a nursing home in Cape Town, where he died.

Miscellanea

CONFERENCE ON ELECTRON MICROSCOPY.—The Institute of Physics is organising the seventh conference on Electron Microscopy, which is to be held in the Physics Department of Leeds University, on Tuesday and Wednesday, September 16th and 17th. The proceedings, which will be concerned with the applications, rather than with the construction, of the electron microscope, will open at 10 a.m. each day.

CEMENT PRODUCTION.—The Minister of Works has stated that the production of cement in the last seven weeks rose from 144,000 tons at the beginning of June to nearly 158,000 tons for the week ending July 21st. Production in the last fortnight was at a higher annual rate than the average annual rate in 1938 but whether it could continue at this high level depended, of course, on the continued supply of coal to the industry.

WOOLWICH ARSENAL STAFF.—In reply to a Parliamentary question, the Minister of Supply stated last week that on July 5th the total number of people employed in the Royal Ordnance Factories, Woolwich, was 8515, compared with 19,641 on July 2, 1938. This total of 8515, the Minister said, was made up as follows: skilled craftsmen, 1857; other industrial employees, 5155; clerical workers, 904; other technical and miscellaneous workers, 599.

ECONOMY IN COPPER TUBES.—The Ministry of Supply has drawn attention to the need for economy in the weight of copper used in hot and cold water systems in buildings and to the importance therefore of using copper tubes only to the thicknesses laid down in British Standard Specification 659/1944. Manufacturers have been asked to discontinue the production of any copper tubes intended for use in hot and cold water systems in buildings which do not conform to this specification. The Ministry of Health has issued a similar instruction to local authorities and water undertakings.

SOCIAL CONDITIONS IN INDUSTRIAL BRITAIN.—A special course of lectures, arranged by the British Council, on the subject of "Social Conditions in Industrial Britain," has just been concluded in Birmingham. It was attended by social workers from Czechoslovakia, Finland, France, Hungary, Italy, Norway and Sweden, and its aim was to give a complete survey of social services and factory welfare in the district. The programme included, in addition to lectures, visits to factories, a labour exchange, a technical college, training centres, housing estates and community centres.

GAUGE AND TOOL MAKERS' ASSOCIATION.—A party of about twenty Members of the Gauge and Tool Makers' Association intends to visit the U.S.A. and Canada in the early part of next year, mainly for the purpose of attending the Exposition and Convention of the American Society of Tool Engineers at Cleveland, Ohio. The party expects to leave England at the beginning of next March and will also visit gauge and tool-making factories in New York, West Hartford, Cincinnati, Detroit and Chicago, returning *vid* Niagara Falls, Toronto and Montreal.

INSTITUTE OF METALS.—The annual autumn meeting of the Institute of Metals is to be held in Glasgow from September 23rd to 26th, with headquarters at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent. Members and their ladies will be officially welcomed on Tuesday evening, September 23rd, at 8 p.m., and at 8.30 p.m. the twenty-fifth Autumn Lecture will be delivered by Professor G. Wesley Austin, on "The Metallurgical Resources of Scotland." On Wednesday morning, September 24th, at 9.45 a.m., papers on "Surface Effects During the Annealing of 70 : 30 Brass" and "The Centrifugal Casting of Copper Alloy Wheels in Sand Moulds" will be discussed. Visits to works and other places of interest will be made in the afternoon, and at 7.30 p.m. there is to be a civic reception at the City Chambers. On Thursday morning, September 25th, at 9.45 a.m., papers on "Frictional Properties of Some Lubricated Bearing Metals," "Corrosion of Magnesium Alloys" and "Metallographic Study of the Precipitation of Copper from a Silver-Rich Copper-Silver Alloy" will be presented for discussion. More visits will take place in the afternoon, and at 7 p.m. in the evening a dinner and dance will be held at the Grosvenor Restaurant. Friday, September 26th, will be occupied by an all-day excursion on Loch Lomond. Sir James Weir French is the Chairman of the Reception Committee, which has been formed to carry out the arrangements for the meeting.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Engineering and Marine Exhibition

Thursday, August 28th, to Saturday, September 13th.—London, Olympia.

Institute of Physics

Tuesday and Wednesday, September 16th and 17th.—The University, Leeds. Conference on Electron Microscopy.

Institute of Marine Engineers

Tuesday, September 9th.—85, Minories, E.C.3. Presidential Address, Sir Amos L. Ayre. Paper: "Steam Pipework Design in Ships." Lieut. (E) P. T. Hoath. 5.30 p.m.

Institute of Metals

Tuesday, September 23rd, to Friday, September 26th.—Annual Autumn Meeting at Glasgow.

Institution of Naval Architects

Tuesday, September 23rd, to Friday, September 26th.—Autumn meetings at Portsmouth and Southampton.

Institution of Production Engineers

Monday, September 8th.—LUTON SECTION: Town Hall, Luton. Film Shows. 7 p.m.

Monday, September 15th.—DERBY SUB-SECTION: Art School, Green Lane, Derby. "Motion Study." Miss A. A. Shaw. 6.45 p.m.

Tuesday, September 16th.—WOLVERHAMPTON GRADUATES: Visit to Hobson Aircraft Company, Ltd. 8.15 p.m.

Wednesday, September 17th.—BIRMINGHAM SECTION: James Watt Memorial Institute, Birmingham. "Cold Upsetting and Thread Rolling." T. C. Parker. 7 p.m.

Thursday, September 18th.—GLASGOW SECTION: Visit to Anderson, Boyes and Co., Ltd., Motherwell. 7.30 p.m.

Works Management Association

Friday, October 3rd.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester. Discussion, opened by A. P. Young.

Personal and Business

MR. H. ADAM, M.I.Mech.E., has joined the staff of Permutit, Ltd.

SIR FRANCIS JOSEPH, BART., has resigned from the board of Birmingham Small Arms Company, Ltd.

MR. W. R. VERDON-SMITH and MR. C. H. DAVY have been appointed directors of Babcock and Wilcox, Ltd.

MR. PERCY GOOD, C.B.E., has been nominated President, and Mr. D. B. Hoseason, a Vice-President, of the Institution of Electrical Engineers.

DR. J. E. RICHARDSON has been appointed Principal of the Northampton Polytechnic, St. John Street, E.C.1, in succession to Mr. S. C. Laws, who has retired after twenty-two years' service.

MR. WILLIAM WALKER has joined the board of Singer Motors, Ltd., to fill a vacancy caused by the resignation of Mr. S. Mayer, K.C. Mr. A. E. Hunt, managing-director, has been elected deputy-chairman.

THOS. W. WARD, LTD., is opening an office in New Zealand, in charge of Mr. Henry Burns, who will be responsible for the complete representation of the firm's interests and also for those of some of the subsidiary companies.

PHILIPS LAMPS, LTD., which includes Philips Industrial, announces that on September 1st its name will be changed to Philips Electrical, Ltd. The headquarters of the company remain at Century House, Shaftesbury Avenue, London, W.C.2.

NEWALL-SENTINEL, LTD., of Shrewsbury and Peterborough, is now handling the sales and distribution of the Newall group of companies and the machine tool products of Sentinel (Shrewsbury), Ltd. Its London office is at 50, Mount Street, W.1 (telephone, Regent 1986).

THE COLONIAL OFFICE announces the following appointments: Mr. J. B. Staunton, executive engineer, Public Works Department, Gold Coast; Mr. Vincent Donoghue, executive engineer, Public Works Department, Jamaica, and Mr. J. H. Common, executive engineer in Fiji.

ZINC PRODUCTION.—The annual report of the Zinc Corporation, Ltd., states that production of zinc ore in 1946 was 448,037 tons, compared with 425,542 tons in 1945.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s. d.
F.I.A.T.		
940	The Manufacture of Nicotinamide and Related Intermediates in the French, British and American Zones of Occupation in Germany	3 8
949	Organic Chemical Intermediates for Insecticides, Fungicides and Rodenticides	4 2
983	The Manufacture of Chloral at I.G. Farbenindustrie A.G., Leverkusen	1 7
B.I.O.S.		
JAP/PR/697	The Honkeiko Colliery Disaster (April 26, 1942)	1 7
JAP/PR/698	The Japanese Salmon Industry	4 2
JAP/PR/731	Manufacture and Uses of Caustic Soda and Chlorine in Japan by the Tokuyama Soda Company, Ltd.	1 1
JAP/PR/741	Veneer and Plywood Manufacturing in Japan	4 8
B.I.O.S.		
925	Tungsten Carbide Research in Germany	9 3
1056	German Acetylene Chemical Industry: Chlorinated Solvents	5 8
1058	German Acetylene Chemical Industry: Ethylene from Acetylene, Coke-Oven Gas and Ethane	8 9
1061	German Acetylene Chemical Industry: Construction Details of Linde Plants	5 2
1064	German Hard-Surfaced Floor Coverings	1 1
1177	Research on the Mechanical Working of Metals: Interrogation of Dr. Ing Werner Lueg, of the Kaiser Wilhelm Institut, Dusseldorf	1 7
1198	Industrial Electronic Control	3 8
1205	Chemische Fabriken, Oker and Bramschweig Atkiengesellschaft, Oker and Harz: Manufacture of Aluminium Hydroxide Pigment (Tonerde-Gel) and Aluminium Sulphate	1 7
1212	German Gelatin and Hide Glue Industry	14 4
1217	Investigation of Pentaerythritol Manufacture in Germany	1 7
1219	The use of Cellulose Derivatives as Core Binders in German Foundries	1 1
1228	H. F. Instruments and Measuring Techniques	3 2
1254	Report on Nestler's Automatic Logarithmic Dividing Machine and Other Targets	4 8
1260	German Lens Manufacturing Equipment	2 2
1298	Phosphating Processes in Germany for the Surface Treatment of Iron and Steel	7 3
1305	Production of Mersol Products at I. G. Farbenfabrik, Wolfen	1 1
1316	German Quartz Clocks	1 1
1331	I. G. Farbenindustrie A.G. Ludwigshafen, Leverkusen and Elberfeld: Formaldehyde and Hexamethylenetetramine	1 1
1334	Investigation of German Industrial Jewels and Agates	1 7
F.I.A.T.		
532	Equipment for use with Oxygen and Fuel Gases for Welding and Cutting	7 3
824	The Miscellaneous Glass Industry of Central Europe	8 3
906	Styroflex-Spiral Submarine Cable	2 8
936	Preparation of Higher Vinyl Ethers at Ludwigshafen	1 1
989	Alumina Production in Germany	1 7
992	The Electrothermal Production of Aluminium Silicon Alloy	1 1
997	German Research in the Light Metals Industry	1 7
1013	Dispersing Agent 88.I.G. Farbenindustrie A. G. Hoechst	0 7
1017	Solid and Liquid Acetylene	1 1
1020	"Caedax": A Synthetic Substitute for Canada Balsam in Microscopic Techniques	0 7
B.I.O.S.		
Misc. 21	Food Yeast Production and Utilisation in Germany	15 4
Misc 31	Manufacture of Food Yeast from Sulphite Liquors at Westphalian Zellstoff A. G., Wildhausen, Germany	1 1
JAP/PR/814	The Japanese Agar Agar Industry	2 8
983	I.G. Farbenindustrie A.G. Manufacture of Thioindigoid and Sulphur Dyestuffs at Hoechst and Mainkur	13 4
1183	Anti-Reflection Surfaces on Glass, Optical Cements and Etching Resist for Fine Lines	3 8
1186	German Leathercloth and Related Coated Fabrics Industry	6 8
1190	German Cable Industry	7 9
1239	Wool-Preparing, Dyeing and Finishing: Discussions with I.G. Personnel	2 8
1288	German Wire Netting Manufacture	3 2
1289	German Drawing Instrument Industry	7 2
1290	German Acetylene Chemical Industry: Vinyl Chloride	2 2
1300	German Stationary Steam Engine Industry	4 8
1306	The Manufacture of Klinker Bricks and Tiles in Germany, with particular reference to the production of Blue Goods from Continuous Kilns	12 3
1311	Design and Performance of the Tatra V-12 Air-Cooled 14·8 Litre Oil Engine	4 8
EVALUATION REPORTS (Post free, 3d.)		
C.I.O.S.		
E/R/12	I. G. Production of Synthetic Fatty Acids.	
E/R/110	H. Walter Kommanditgesellschaft: Experiments on Aircraft Catapulting Device, Torpedoes and Mine Detonation.	
E/R/116	Chemical Research Laboratory of Doctor Bruno Boettcher.	
E/R/215	Report on Aircraft Instruments, &c.: Produced by firm Albert Pattin of Berlin and Wesben.	
E/R/332	Carl Schenck, G.m.b.H.: Testing Machines and Balancing Machines.	
B.I.O.S.		
E/R/408	Ruhrstahl A. G.: Wheels and Axles for Locomotives and Railway Rolling Stock.	
XXXIII–55	Coke Ovens in the Ruhr and Watenstedt Districts. (Appendix No. 2, C.I.O.S. Report XXXII–1·9.)	1 1
F.I.A.T.		
594	High Pressure Chemical Liquid Pump, Force Feed Lubricators, Positive Rotary Supercharger. (Manufactured by Robert Bosch G.m.b.H., Stuttgart.)	1 1
665	German Fertilisers and Soil Fertility	5 2
835	A Technological Study of the Wall and Floor Tile Industry in Germany, Austria and Czechoslovakia	2 2
903	Cosmetic, Perfumery and Soap Formulae	9 3
951	The German Gasket Industry	1 7
974	Thermostatic Bimetal Production in Germany	2 2
981	The Dyeing of Glass Fibre Textiles	0 7
985	The Production of Ammonium Sulfate from Calcium Sulfate at Oppau	1 1
986	Carbon Electrodes in Germany for the Aluminium Reduction Industry	1 7
990	Production Cycles for Manufacture of Cellulose Acetate and Cellulose Propionate at I.G. Farbenindustrie A.G. Dermagen	1 1
J.I.O.A.		
78	High Frequency Technical Ceramic Materials of Germany	3 2
B.I.O.S.		
JAP/PR/100	The Coal Industry of Japan in recent years	4 2
EVALUATION REPORTS		
C.I.O.S.		
E/R/19	Statistics of German Production, Consumption and Stocks of Liquid Fuels, Rubber and Strategic Chemicals	
E/R/66	Pulp and Paper Activities in the Mannheim, Darmstadt and Heidelberg Area.	
E/R/76	Brown-Boveri Company: Marine Engineering.	
E/R/121	Dynamit A.G. Small Arms Factory.	
B.I.O.S.		
E/R/257	Brown Boveri and Cie, A.G.: The Gas Turbine in the Foundry.	

B.I.O.S. Information Section, 37, Bryanston Square, W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

G.W.R. Works at Port Talbot

THE Great Western Railway Company announces that it has placed a contract for extensive railway engineering works designed to serve the new strip mills at Margam, Port Talbot. These works include the diversion and doubling of nearly 1¼ miles of railway, the provision of two new marshalling yards with subsidiary lines and sidings totalling 24 miles of track, the construction of six large bridges with spans varying between 108ft skew span and 29ft square span, two viaducts totalling seventeen spans and 500 yards of retaining wall, the laying of several hundred yards of pipe for draining the large area of marshland covered by the Margam site, the construction of two small bridges over the drainage waterways and the extension of existing brick and masonry culverts. It is hoped that the whole of the work will be completed in two years. In addition, the G.W.R. proposes to make some improvements at its Port Talbot Docks in order to cope with bigger shipments of iron ore. The main discharging quay is to be lengthened, five hydraulic pumps for supplying power on the quayside are to be provided and impounding pumps will be installed with a capacity of 66,000 gallons a minute for maintaining the water level in the dock. The total cost of the two schemes will, it is anticipated, exceed £600,000.

River Lee By-Pass Scheme

APPROVAL has now been given by the Ministry of Agriculture and Fisheries to a scheme for constructing a by-pass of the River Lee from Hackney to Tottenham as part of the Lee Valley flood relief works. The scheme was first approved by the Ministry as qualifying for a grant at the beginning of 1939, but the work had to be deferred on account of the war. The project includes the widening and improvement of the River Lee from a point near Carpenters Road bridge, Stratford, to a point on the Hackney Marshes, and from there it is proposed to build the new flood channel which will have a length of about 3½ miles. The channel will extend across the Walthamstow Marshes and will join the River Lee diversion near Chalk bridge, Edmonton. It will, it is estimated, intercept about three-quarters of the flood water which now enters the navigation below Tottenham lock. As well as the construction of a number of bridges, the work will include the widening of the Pymmes Brook and the improvement of the Moselle Brook in the borough of Tottenham. When the scheme was originally prepared it was stated that the cost would be £1,200,000, but the figure now mentioned is approximately £2,000,000.

The Gidea Park Railway Accident Report

THE report of an inquiry by Lieut.-Colonel E. Woodhouse, Inspecting Officer of the Ministry of Transport, into an accident on the Liverpool Street to Colchester line of the London and North-Eastern Railway at Gidea Park Station, on January 2nd, was published at the end of last week (H.M. Stationery Office, price 1s.). The accident was caused by the 10.25 p.m. train from Liverpool Street to Peterborough colliding with a Southend train which was starting from Gidea Park Station. The speed of the Peterborough train at the time of collision was estimated to be 30 to 35 m.p.h., the three rear coaches of the Southend train were wrecked, seven passengers died through the accident and forty-five received injuries necessitating detention in hospital. There was dense fog at the time. Colonel Woodhouse says in his report that the direct cause of the accident was the serious mistake of the driver of the Peterborough train in continuing to run at fairly high speed through the Romford-Gidea Park section while uncertain of his location and in ignorance of the indications of signals which he was unable to see. Colonel Woodhouse makes the further comment, however, that if the driver had had a definite warning when approaching Romford that the stop signals there might be against him—in other words, had a detonator been exploded at the distant signal—there would have been less likelihood of his subsequent mistake. In some general remarks, Colonel Woodhouse expresses the opinion that probably the accident would not have happened with colour-light signalling in place of oil-lit semaphores, or if automatic train control apparatus had been in use. The report adds that if the war had not interrupted the resignalling programme, multi-aspect colour lights would have been in use between Liverpool Street and Gidea Park in westward prolongation of the existing installation extending from Gidea Park to Chelmsford and Southend.

Manchester-Sheffield Railway Electrification

WITH the approval of the Ministry of Transport, the London and North-Eastern Railway Company is to resume the work of electrifying its Manchester-Sheffield main line, together with the lines from Barnsley Junction to Wath and from Fairfield to Trafford Park and Manchester Central, a total of 300 track miles, including sidings. It is expected that the work will take four years to complete, that the cost will be round about £6,000,000 and that there will be an annual saving of 100,000 tons of coal as a result of electrification. The Manchester-Sheffield line has very heavy gradients, and near its summit, 943ft above sea level, the Pennine range is pierced by the Woodhead tunnel, which is more than 3 miles long. The L.N.E.R., it may be recalled, has recently obtained parliamentary powers to build a new double-line tunnel parallel with the existing Woodhead tunnel. An extremely dense traffic is worked over the route, about six out of every ten trains conveying coal. The electrification scheme was well in hand, and all the main contracts placed, before the outbreak of war in September, 1939, when work had to be suspended. It was, however, found possible to complete at Doncaster the first 1870 h.p. mixed-traffic electric locomotive, which underwent successful trials on the Manchester-Altrincham electric line in the autumn of 1941. Certain modifications were subsequently carried out and the locomotive has recently made further trial runs on the Manchester-Altrincham line. The overhead line conductor system, using d.c. at 1500V, will be employed. This system is similar to that which has been in use on the Manchester-Altrincham line for the past sixteen years and is now being installed on the L.N.E.R. main and suburban lines from Liverpool Street and Fenchurch Street to Shenfield. Electric locomotives will haul all trains between Manchester and Sheffield and they will be fitted with electrically heated boilers so as to maintain steam heating in the passenger trains. Between Manchester (London Road), Hadfield and Glossop, however, a suburban service will be provided by multiple-unit electric trains.

Diesel-Electric Locomotives for the Southern Railway

IT is announced that the Southern Railway Company has ordered three express diesel-electric locomotives capable of hauling main line passenger express trains at maximum permissible speeds, which means that the locomotives will be capable, under certain conditions, of reaching 100 m.p.h. Construction will start shortly in the company's own workshops at Brighton, and it is expected that the new locomotives will be in service towards the end of 1948. Each locomotive will have a 1600 h.p. diesel generator, which will supply electric power to six axle-hung traction motors mounted on the bogies. The diesel-electric equipment is to be supplied by the English Electric Company, Ltd. The body and underframe of the new locomotives will be mounted on two eight-wheeled bogies, three of the axles in each bogie being driven. Each locomotive will weigh approximately 120 tons in working order and will be 62ft in length. A driver's cab will be fitted at each end, whilst the portion of the body between the cabs will house the diesel generator, auxiliary machinery, control apparatus and fuel tanks. The locomotives are so designed that two can be coupled together to haul the heaviest trains of 500 tons at express speeds under the control of one crew. It is stated by the company that the use of oil fuel will produce a considerable saving in coal consumption and, owing to the saving of time required for maintenance and refuelling, the availability of the new locomotives for traffic purposes will be considerably higher than for steam locomotives of comparable size. In the first place the locomotives will operate in the principal express services on the West of England route between Waterloo, Exeter and Plymouth, but they will be capable of working on any other main line route of the Southern Railway.

Britain's First Atomic Pile

THE Ministry of Supply says that the first atomic pile in this country started up at the Atomic Energy Research Establishment, Harwell, during last weekend. This pile, known as the Gleep (graphite low energy experimental pile), is the first major unit to be completed at Harwell, and has been built primarily for experimental work in nuclear physics. It will, however, be used for the time being, until the more powerful Harwell pile comes into operation in 1948, for the production of small quantities of radioactive isotopes for biological and medical research. These radioactive materials are required in the first place for the work of the Medical Research Council, but their use is likely to extend in science generally and in industry. The pile has been designed largely by a New Zealand group of scientists working at Harwell, though many British scientists have contributed to the production of the pure graphite and uranium, and have designed and produced the instruments required for the pile. Considerable assistance has also been obtained from Canada, particularly in the testing of graphite. The engineering and constructional work on the pile has been done by the Ministry of Works and its contractors, W. E. Chivers and Sons, Ltd., and Matthew Hall and Co., Ltd., in fifteen months from starting work on the site.

The Whitehaven Colliery Disaster

SHORTLY before six o'clock on Friday evening last, August 15th, a serious explosion occurred in the William coal mine, Whitehaven, Cumberland. The mine runs under the sea off the Cumberland coast and the heavy falls of roof caused by the explosion trapped most of the 117 men who were at work in the pit. Ten of the men were away from the affected area, and after giving the alarm they joined in the rescue operations, which went on unceasingly throughout the week-end. On Saturday afternoon, three more men, after making a perilous journey along the wrecked galleries of the pit, met a rescue party, approximately twenty-one hours after the explosion. According to the colliery manager, these three men were saved through following sound mining practice. On Sunday evening it was announced with regret that there was little hope of finding any of the remaining 104 men alive. As we go to press, most of the bodies of those men who unfortunately lost their lives have been recovered. Well-deserved tribute has been paid on all sides to the arduous work of the twenty rescue teams, and telegrams expressing sympathy with the relatives of those who perished were sent immediately after the disaster by Their Majesties the King and Queen and by the Cabinet. Lord Hyndley, the Chairman of the National Coal Board, visited Whitehaven on Sunday.

Testing of Flatness by the Beam Comparator Method*

By R. MARRINER and W. O. JENNINGS, B.Sc.

THE method of testing flatness to be described was devised at the National Physical Laboratory and used during the war for testing quickly and with reasonable accuracy large batches of surface plates of the same size. It can, moreover, be used with some advantage for single surfaces and is particularly convenient for testing the flatness of surfaces during manufacture.

Principle of Beam Comparator Method

Reduced to its simplest essentials, the principle employed is that of comparing by means of a sensitive dial indicator the straightness of a succession of generators in the surface under test with that of a known reference straightedge. The comparator measures, in effect, the vertical displacement of the mid-point of any particular generator with respect to a theoretical straight line joining its ends. Such measurements reveal information on the apparent convexity or concavity of each generator which may be used to determine the general departures of the surface from a mean true plane.

It is clear that if both diagonals of a rectangular surface are established by such means to be concave by, say, 0·002in, then the whole surface must be generally concave and cannot be flat to better than 0·002in. Similarly, if one diagonal is concave and the other convex by 0·002in, then the surface is of the type described as "in wind," and cannot be flat to better than 0·004in.

In order to obtain the departures from a mean true plane of other points between the corners and the centre, other generators, shorter than the diagonals, are examined for their relative convexity or concavity. Having once assigned values to the corners and centre from the diagonal measurements, it is a matter of simple proportionate adjustment to derive the values of these other points from the measurements of the shorter generators. A suitable scheme is described for tabulating results and for obtaining from them the general departures of the surface from a mean true plane.

Description of Apparatus

The body of the comparator consists of a robust but light beam having three supporting feet, one fixed at the centre of the beam but offset from the line joining the other two (see Fig. 1). These two feet may be clamped to the beam in symmetrically disposed positions with respect to the central foot and at a distance apart depending upon the size of the surface under test. All the feet are of hardened steel and are spherically ended.

The central web of the beam is suitably bored to take the stem of a high quality 0·0001in indicator (range ±0·002in) so that the axis of the spherically ended contact plunger of the indicator lies in the plane through the axes of the two adjustable feet.

With the arrangement of three locating feet and one measuring plunger just described, the beam is accidentally liable to be rolled over on the side not supported by the offset foot. To guard against undesirable displacements of this nature, a fourth foot, in the form of a spherically ended spring plunger, is provided at a position symmetrically opposite the fixed offset foot. Normally, this plunger foot is adjusted to be reasonably clear of the surface plate; it only comes into operation if the beam receives an impulse tending to roll it over towards this foot and restores the beam to equilibrium.

The readings of the indicator are calibrated by placing the beam comparator on a reference surface, the straightness of which has previously been accurately determined by means of an auto-collimator or precision level†. By allowing for the known errors in straightness of the reference surface, the reading of the indicator corresponding to location of the beam on a truly flat surface is known.

As the beam comparator is most frequently applied to testing surface plates with a scraped finish, it is supported upon equal slip gauges or lapped pads on both the reference and test surfaces. The purpose of these slips or pads is to ensure that the feet of the beam comparator do not accidentally locate in the hollows of the scraped surface and also that the survey is made with respect to the high spots of the surface.

Method of Use

The beam comparator is very simple to use and the departures of a surface from a true plane can be readily derived from the results of the comparator measurements. To illustrate more clearly the process adopted for compounding the results obtained from single generators, a complete set of observations and calculations appertaining to the test of a 36in by 24in surface plate is given in the accompanying table.

As many generators as desired may be tested, but in the majority of cases it is sufficient to test eight. The eight selected generators are disposed on the surface in a "Union Jack" pattern, as shown in Fig. 2. Additional readings are obtained on the semi-diagonals of span AX, BX, CX and DX, which are all equal to 19½in for this size of plate.

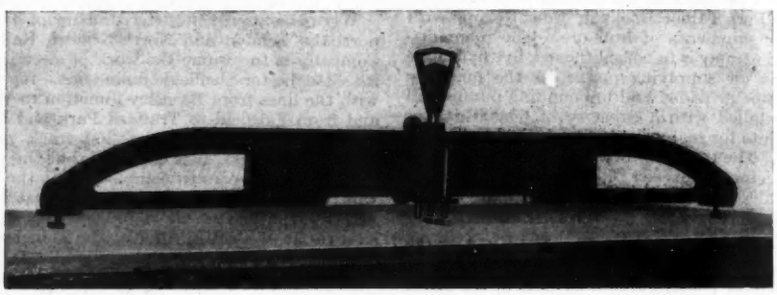


Fig. 1—Beam Comparator

The span of the adjustable feet is set in turn for each of the different generators and observations are taken first on the reference surface, then on the surface plate, and finally on the reference surface again. For instance (see table), with the adjustable feet set symmetrically about the indicator plunger to a total span of 39in (col. 2), the beam comparator gave a reading of 10·0 divisions on the reference surface (col. 3). As the central region of the span on the reference surface was known to be hollow by 0·00003in, *i.e.*, equivalent to −0·3 division on the indicator (col. 4), the indicator gave a reading of 0·00003in less than it would have done on a truly flat surface. Thus, the indicator would be expected to

Example of Method of Recording the Observations and Calculations Relating to the Test of a 36in by 24in Surface Plate.

One division of the indicator equals 0·0001in.

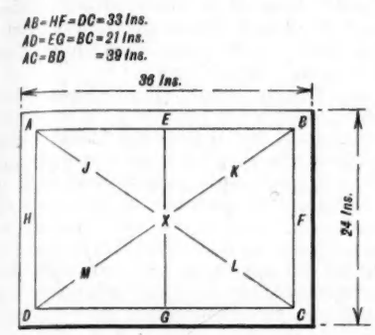
1		2	3	4	5	6	7	8	9
Generator	Central point.	Span (inches)	Reading on reference surface.	Error of reference surface.	Corrected reference reading (col. 3–col. 4).	Reading on test plate.	Convexity or concavity of generator (col. 6–col. 5).	Basic reading at centre of span.	Results.
AC	X	39	10·0	−0·3	10·3	10·7	+0·4	0·0	X +0·4
BD	X	39	Repeat 10·0	−0·3	10·3	9·5	−0·8	—	D +2·4
AB	E	33	9·8	−0·2	10·0	10·2	+0·2	0·0	E +0·2
HF	X	33	Repeat 9·8	−0·2	10·0	9·8	−0·2	+0·6	(X′ +0·4)
DC	G	33		−0·2	10·0	10·4	+0·4	+1·2	G +1·6
AD	H	21	7·6	0·0	7·5	7·7	+0·2	+1·2	H +1·4
EG	X	21	Repeat 7·4	0·0	7·5	7·0	−0·5	+0·9	(X″ +0·4)
BC	F	21		0·0	7·5	7·3	−0·2	0·0	F −0·2
AX	J	19½	10·5	+0·1	10·4	10·6	+0·2	+0·2	J +0·4
BX	K	19½	Repeat 10·5	+0·1	10·4	10·5	+0·1	+0·2	K +0·3
CX	L	19½		+0·1	10·4	10·2	−0·2	+0·2	L 0·0
DX	M	19½		+0·1	10·4	10·0	−0·4	+1·4	M +1·0

*Communication from the National Physical Laboratory.

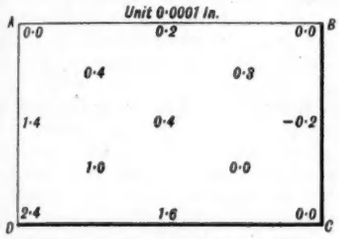
† See: F. H. Rolt, "Tests for Straightness by Inclination Method," The Engineer, Vol. 163, page 326 (1937).

read 10·3 divisions (col. 5) on a truly flat surface. The comparator was then transferred to the test plate, the end feet being placed first at A and C (thus spanning the diagonal AC (col. 1)), whereupon the indicator read 10·7 divisions (col. 6) for the local area at X (see Fig. 2).

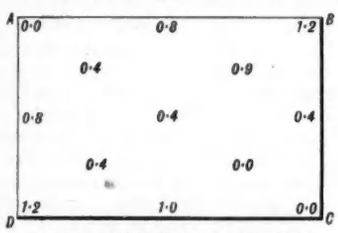
The comparator was then turned until the end feet were stationed at B and D, and an indicator reading of 9·5 divisions (col. 6) was obtained for the local area at X. Note that in this case the position of X was referred to the straight line joining



SCHEME OF TEST FOR A SURFACE PLATE.



MEASURED ERRORS REFERRED TO ARBITRARY DATUM PLANE THROUGH POINTS A=B=C=0.



RESULTS REFERRED TO A DATUM PLANE SELECTED TO GIVE BEST DISTRIBUTION OF ERRORS.

"THE ENGINEER"

FIGS. 2, 3 AND 4—DIAGRAMS OF TEST

points B and D, whereas previously it was referred to the straight line joining points A and C.

Thus one setting and calibration of the comparator span serves for checking the centre point of two diagonals on the plate. Also the semi-diagonals AX, BX, CX and DX, with their four corresponding central points, J, K, L and M, can be accommodated with one span (19½in) of the comparator and a single calibration. When a number of similar plates require testing, they are arranged around the reference surface and similar spans on all the test plates are handled at one setting of the beam comparator.

It has already been indicated that by subtracting the errors of the reference surface given in col. 4 from the mean of the corresponding readings given in col. 3, the readings of the indicator on a perfectly flat surface are obtained, as shown in col. 5. The departures of the mid-points of the generators in the surface plate under test from straight lines are then obtained by subtracting the entries in col. 5 from the corresponding readings in col. 6. The differences thus computed are entered in col. 7, a + sign indicating convexity and a − sign concavity.

Correlation of Results Obtained in Different Generators

The following procedure is used to derive the departures at various points on the surface from some arbitrary datum plane. For convenience, the datum plane selected is that passing through the points A, B and C of the surface plate to which zero errors are accordingly assigned.

From the observations in the table it is seen that the generator AC is convex by 0·00004in, so that, with respect to the datum plane, the value to be assigned to X is +0·00004in (shown as +0·4 in units of a ten thousandth of an inch in Fig. 3).

The next step is to assign a value to D. From the observations the generator BD is concave by 0·00008in, entered in col. 7 as −0·8. But it has already been established that the value to be assigned to X with respect to the datum plane ABC is +0·00004in. Since X is a point common to both diagonals, it is therefore necessary to adjust the direction of the generator BD about its end-point B until the mid-point coincides with the assigned value of X. To do this the mid-point of generator BD must be raised 0·00012in, and therefore the other end D of the generator must be raised in proportion, that is by twice this amount. Thus, the value assigned to D with respect to the datum plane is +0·00024in. It is helpful to note that the value of D is given by twice the reading for AC minus twice the reading for BD given in col. 7, taking due regard of the signs of these quantities.

To obtain the values for E, F, G and H, the following reasoning is applied. As the values assigned to A, B and C are zero, then the values of E and F would also be zero if generators AB and BC were straight. Similarly, as D is +0·00024in and A and C are zero, then if generators AD and DC were straight the values of H and G would be +0·00012in. These "basic" values are entered in the appropriate rows in col. 8. It is helpful to note that the "basic" value for the mid-point of any span is the mean of the values already assigned to the end-points.

Now, from the values given in col. 7, it is seen that generator AB is not straight but is convex by 0·00002in. Therefore, the value to assign to E in col. 9 is +0·00002in above its basic value of zero, and is simply obtained by adding algebraically the values in the same row of columns 7 and 8. Similarly, the values for G, H and F in col. 9 are the algebraic sums of the values in col. 7 and col. 8.

The basic values for Xft and Xin (col. 8) are obtained by making use of the results given in col. 9 for E, F, G and H. The results in col. 9 for X′ and X″ are obtained by combining col. 7 with col. 8. X′ and X″ are positions which are obviously coincident with X, but the values of X′ and X″ are derived from spans HF and EG, respectively, whereas the value already assigned to X is derived from span AC. These values for X′ and X″ should be the same as the original value for X, and therefore act as convenient checks on the accuracy of observation.

The values for J, K, L and M are obtained by exactly the same process as the values for E, F, G and H.

Adjustment of Datum Plane

The results obtained in col. 9 are more easily comprehended when plotted as in the diagram, Fig. 3.

It will be seen that the surface lies entirely within two planes 0·00026in apart and it could therefore be said that the surface lies within ±0·00013in from a mean true plane.

It will be remembered, however, that the datum plane was quite arbitrarily chosen to pass through the points A, B and C and therefore is not necessarily the "mean true plane." The term "mean true plane" as used with reference to surfaces is capable of a number of interpretations and, according to the interpretation chosen, may be derived from the values of the observed points.

However, for the type of surface suitable for test by the method described, elaborate calculations are unnecessary and a visual inspection of the results is usually sufficient to decide the most suitable "mean true plane."

For instance, by rotating the datum plane through ABC in Fig. 3, about the line AC, by an amount corresponding to 1·2 at D and B, the final results shown in Fig. 4 are obtained, and it is apparent that the surface lies within ±0·00006in from a "mean true plane." The accuracy of determination is estimated to be 0·00003in.

It should be emphasised that after a little practice the working up of the observations can be carried out purely arithmetically and without the detailed reasoning given above. With experienced observers it is found that a surface plate of size 36in by 24in can be completely tested within twenty minutes, and twelve such plates within two hours.

This account of a novel and rapid method for testing the flatness of surfaces is published by permission of the Director of the National Physical Laboratory.

Powder Metallurgy

No. VI—(*Continued from page 154, August 15th*)

WE continue below the discussion on Section F, "The Manufacture and Properties of Sintered Components."

Dr. C. H. Desch, F.R.S. (President, Iron and Steel Institute), said that he could see the great advantages which could be obtained with some alloys by using this method of preparation; but in the case of the iron-carbon alloys he was still not convinced of what was to be gained by the use of this method when the aim was not to produce a porous material but to have a solid material.

With regard to the cost, compared with machining there was naturally an immense saving, but it is also necessary to compete with the method of precision casting, which was gradually being improved and which, of course, gave a product very greatly superior in mechanical properties to anything which could be prepared by the powder metallurgy method. The iron-carbon compacts had a fairly good tensile strength, but very poor elongation as a rule. When they heard that these could be improved by forging under a press, they could not but

wonder why an ordinary steel should not be used to begin with.

In March last he had visited the big Department of Powder Metallurgy at the Stephens Institute at Hoboken, U.S.A., and had obtained specimens, which were of about the same quality as was described in these papers.

Only one paper mentioned carbonyl iron, saying that it was relatively hard and costly, but he had found that at Hoboken they were using mainly carbonyl iron. It had the advantage of having spherical particles, and he was surprised at the statement that it was hard, because his experience was that it was soft. These spherical particles gave a very compact mass when packed together, and in preparing alloys of this kind from an iron powder it seemed to him that this would be the ideal powder for the preparation. No doubt the carbonyl process is expensive, but it was extensively used in Germany, and even sheet and plate material were prepared there from sintered carbonyl iron. When it is necessary to have a porous product this was an admirable method, but he was not convinced from these papers of the value of the method for making steel.

Mr. L. J. Brice (Ministry of Supply) expressed interest in the remarks of Dr. Jones with regard to the D.P.G. process. He had recently discussed the matter with an Austrian metallurgist, now associated with an Austrian firm developing the very same D.P.G. process, and producing on that machine 2 tons of steel powder a day. From the steel powder produced by this method the firm had already made rolled products and drawn products, and were on the way to producing wire of a quality suitable for use in mine haulage ropes and so on. They were also producing welding rods, particularly those in which the flux was integrally mixed with the powder, rather than forming a coating or core, as well as sintered products. He was also told of new developments in the direction of producing alloy steel compacts. This information could not be divulged through B.I.O.S. channels, but introductions could be arranged if desired. He took the opportunity of adding two or three B.I.O.S. report numbers to those given in Mr. Leadbeater's paper, and urged that the question of standardisation of components, techniques and products should be given serious attention at an early date.

Mr. S. J. Garvin (Murex, Ltd., Rainham, Essex) said that he agreed with Dr. Jones as regards the D.P.G. disc-atomising process. In Germany he had visited a place where a number of these machines had been in use, and the people there claimed that they used to break down every other day. He did not know whether the Austrians were having more success, or had developed the machine further.

The Germans were developing a new method of producing atomised iron powders which consisted of an air atomisation of high carbon iron, and the resulting particles then have to be produced. That seems to be a very interesting process, because it produces large quantities of powder comparatively cheaply, and the particles are spherical in shape and soft and can be made to retain part of their carbon, or the carbon can be eliminated completely by reducing in hydrogen.

On the two papers relating to iron-copper parts made by sintering, it struck him that nobody had referred to the precipitation hardening properties of the iron-copper system. The solubility of copper in iron decreased from about 8 per cent to somewhere below 2 per cent between 1050 deg. Cent. and room temperature. Most of the sintering was done at temperatures above 1050 deg. Cent., so that there might definitely be a precipitation hardening effect. This was borne out also by the test results given in the paper by Northcott and Leadbeater, where Fig. 1 showed the influence of copper content on the properties of sintered compacts. There they obtained the maximum tensile properties with a copper content of approximately 24 per cent. In Fig. 16 they showed the relationship between tensile strength and copper contents for different porosities, and in each case the maximum tensile was obtained with about 10 per cent copper. He wondered whether the cooling rate had had anything to do with this apparent discrepancy in the results.

Mr. C. E. Richards (Post Office Research Station) said that Dr. Desch had raised a question which kept cropping up about carbonyl iron. Carbonyl iron, when first made by the decomposition of iron carbonyl, usually contains about 0·6 per cent to 1 per cent of combined carbon and about 0·25 per cent nitrogen, and in those circumstances it is exceedingly hard. That was the material which was used for most magnetic purposes. The carbonyl iron which was described in most of the text-books, and which was used for powder metallurgy generally, had been decarburised, usually by the hydrogen treatment, down to about 0·1 per cent carbon, and was completely soft. The Americans had an additional decarburised grade which, he understood, was largely used. It is known as Grade L and was not available over here in quantity. It was not even spherical; it went through some treatment which produced a non-spherical carbonyl base material. It had been advertised widely by the Americans as an ideal material for powder metallurgy. It had 0·1 per cent or less of carbon and was entirely soft.

Mr. J. W. Lennox (Sintered Products, Ltd.) said that the price of carbonyl powder was in the region of 4s. per pound, whilst that of the type of powder in which fabricators of powdered parts were interested must be around 6d. per pound. Carbonyl iron powder was also extremely difficult to press, probably, he thought, because of its so-called onion structure.

There was an important omission from the paper by Burr and Clarke, in that the authors had not stated the method of pressing. The speed at which the part was pressed was important, and so also was the type of die finish. The experiments were carried out with a die lubricated with a thin film of oil and graphite, but during pressing the powder tended to break through the so-called lubricating film and to give die attack. Lubricating the powder in place of the die wall was quite sound commercially. The work of Wolf and others, as discussed by Dr. Jones, showed what happened to the powder during pressing; but if the powder contained a solid lubricant during pressing it tended to become warm, and a continuous film was maintained during the pressing. The inclusion of stearin, which the authors mentioned as appearing to have detrimental effects on the physical properties, was interesting, but he thought that the authors should give some description of how much was put in. In later papers reference was made to 0·1 per cent and to improved results being obtained. He had found that quantities of the order of 0·1 per cent were quite sufficient, provided that necessary care was taken.

In the paper by Mr. Judd it was stated that pressures of 100 to 150 tons per square inch might be used, but from his experience he thought that to exceed 40 to 50 tons per square inch was asking a good deal of the die steel manufacturer.

It was also stated by Mr. Judd that nickel could be fairly readily diffused at temperatures of the order of 1100 deg. Cent. in a time of thirty minutes. He had carried out fairly extensive work with many iron powders with the inclusion of nickel, but had not been able to get the nickel to diffuse.

It would assist powder users if authors would, instead of referring to powders by numbers, referred to the origin of the powder, because in many instances they would like to get some powder of a particular type, but from the general description given in the text they could not do so.

Mr. Gordon Smith (Mond Nickel Company), referring to carbonyl iron powder, thought that Mr. Lennox had hit the nail on the head when he said that it was the high cost of this powder which prohibited its employment for such uses as they were discussing in that section. Mr. Lennox had also referred to the difficulties in pressing, but he did not think that such difficulties had been confirmed in other directions. That powder in the decarburised state to which Mr. Richards had referred was quite satisfactory for pressing. It was possible that in Mr. Lennox's experiments there might have been some superficial oxidation, as the powder was very fine and was subject to oxidation if not properly stored; but there might have been other reasons for the failure.

That powder was a very useful tool for research because of its high purity. He thought that that was why the Americans had been using it. It had been used in Germany in most of the early stages of German developments in iron powder metallurgy; they had started off with carbonyl iron powder, and when going into production had found what necessary modifications had to be made to make a cheaper powder.

Dr. L. Northcott (Armament Research Department) said that in the paper by Chadwick, Broadfield and Pugh on iron-copper compacts, the improvement in mechanical properties was largely accounted for by mutual diffusion. He would like to ask the authors whether an annealing treatment of a quarter of an hour (or even four or five hours) was going to permit diffusion of copper into iron. The iron would certainly diffuse into the copper, partially, at any rate, because the copper was in the liquid state, but he could not imagine much in the way of diffusion of copper into solid iron. The same point arose with regard to nickel. Apart from carbon and hydrogen, and one or two other elements, we knew from general steel practice that the solid metals did not readily diffuse in steel until you got up to a very high temperature, a little below the melting point, and kept there for a considerable time.

His own view was that the improvement in properties of the iron alloys by the presence of copper was due to the extent of 99 per cent to the increased bonding action. The question of cohesion had already been raised. The strength of sintered components of the engineering type was largely due to the cohesion between the different individual particles, and any circumstance such as the existence of a liquid phase, or, if there is no liquid phase, any treatment which would render the surfaces more readily cohesive to one another, would increase the mechanical properties. He felt convinced that any increase in properties due to a precipitation hardening effect as suggested by Mr. Garvin was very small compared

with the benefit obtained from the increased cohesion between one particle and another owing to the presence of the liquid phase.

Mr. Garvin had referred to Fig. 16 in the paper by Mr. Leadbeater and himself, where the peak in the tensile strength/copper per cent curve occurred at about 10 per cent. Their only somewhat speculative suggestion was that with 10 per cent of copper under the conditions which they used they had the maximum penetration per unit weight of copper and the formation of the optimum thickness of copper as bond.

In view of comparisons which arose it was difficult for representatives of a neutral organisation to give the names of manufacturers of the powders as Mr. Lennox wished. They had tried carbonyl iron. Apart from the question of expense, which was easily the most important single factor, it was not a convenient material to handle, largely owing to its fine particle size and it did not flow readily.

Lieut.-Col. W. Ivory (Armament Research Department) in reply, added that the Germans only achieved success with the sintered iron driving band after they had taken steps to standardise the characteristics of the powder, and it seemed to him that the powder metal industry in this country would be well advised to support any proposals for standardising the materials and methods of testing they used.

The Manufacture and Properties of Sintered Non-Ferrous Components

Dr. Maurice Cook then presented the remaining papers of Section F, dealing with Non-ferrous Components, *viz.*, (23) "A Note on the Powder Metallurgy Methods used in Great Britain for the Manufacture of Plain Bearings and Thrust Washers," by W. H. Tait; (24) "The Pressing and Sintering of Copper Powders," by Maurice Cook and S. F. Pugh; (25) "The Production of Some Non-Ferrous Engineering Components by Powder Metallurgy," by J. W. Lennox; (26) "Aluminium Components," by R. L. Bickerdike; (27) "Notes on German Developments in Non-Carbide Powder Metallurgy," by C. J. Leadbeater.

Dr. Maurice Cook, taking the papers in turn, said that Mr. Tait's paper was a concise and interesting account of powder metallurgy methods used in this country for the manufacture of plain bearings and thrust washers, in which he first discussed the reasons which made them so valuable in producing porous structures which would hold oil and alloys difficult to obtain by other processes.

The idea of porous bearings originated in the U.S.A., as far back as 1916. Since then development had been very considerable, and the present output was reckoned in millions per annum. The author noted that in this country there had been no outstanding advance in this branch of powder metallurgy, and production was generally along American lines.

The author went on to describe the technique usually employed, and the materials used—90/10 copper-tin bronze containing up to 1·5 per cent of graphite, copper-tin-lead alloys, and also iron-copper alloys, which were not used very much in this country. They had a higher load-carrying capacity at slow speeds than the tin and tin-lead bronzes, but at moderate and higher speeds they were inferior to the bronzes.

Porous bearings were not so strong as the solid metal bearings, and the frictional heat generated was not dissipated by a flow of oil as it was in normal lubrication practice. Their use was therefore limited to a PV value of 50,000 (where P was the pressure in pounds per square inch of projected bearing area and V the peripheral velocity of the journal in feet per minute) and generally to velocities not exceeding 500ft per minute.

In the field of non-ferrous bearings which were non-porous, attention had been chiefly directed to copper-lead and lead-bronze materials, bonded to a steel back. Among newer developments which were not yet commercially available, the author referred to steel-backed porous bronze bearings and to oil well porous bushes, *i.e.*, a composite oil well and porous bush.

There were two appendices to the paper. One was concerned with the structure of the copper-lead bearings, including a type, which the author called "the two interlinked sponges, readily produced by carefully controlled powder metallurgy methods. The other dealt with the low elastic modulus associated with porous metallic aggregates.

Dr. Cook then referred to the paper by Mr. Pugh and himself, dealing with an investigation into the pressing and sintering of electrolytic, oxide reduced, and chemically precipitated copper powders of various particle-size gradings. The methods used for evaluating those powders, for compacting the products (with incorporation of 0·1 per cent of zinc stearate) and testing them were described in some detail. Pressing loads ranging from 15 to 65 tons per square inch and sintering temperatures ranging from 750 deg. to 1050 deg. Cent. were employed. It was of interest to note that the electrolytic and the precipitated powders had microstructures similar to that of massive copper, even showing the characteristic twin crystals, while the reduced powder showed no visible grain structure even at very high magnifications; but it did show numerous very small, fine dark markings, which appeared to be minute fissures, possibly resulting from the processes of oxidation and subsequent reduction and favourable to absorption of gases, which would be evolved during sintering. The electrolytic and precipitated powders could be compressed under moderate loads to yield, after sintering, products of relatively high tensile strength, of the order of 10 to 12 tons per square inch, and that was achieved with quite small dimensional change, whereas there was a general tendency to show expansion and lower tensile strength in compacts made from reduced powders.

The third paper, by Mr. Lennox, described experiments carried out with the object of establishing optimum techniques for the production of high-density components in 70/30 brass and 90/10 tin-bronze, with maximum tensile strength and elongation values. Compacts of 70/30 brass prepared from unalloyed powder mixtures expanded considerably with evolution of zinc vapour, and distortion was pronounced. Partially alloying the mixed powders before pressing resulted in considerable improvement, but the best results were obtained with the fully alloyed powder. The maximum density was obtained with the highest pressure used, 50 tons per square inch, when the sintering was carried out at 810 deg. Cent. and 900 deg. Cent. The preferred procedure for making the 70/30 brass alloy was to use alloy powder with a die lubricant, cold pressed at 30 to 35 tons per square inch, sintered at 900 deg. Cent. in hydrogen or cracked ammonia, re-pressed as before and then re-sintered as before. Reduced die wear and increased accuracy in dimensions warranted the extra cost of re-pressing and re-sintering.

In contrast with the brass products the 90/10 tin-bronze compacts were satisfactorily prepared from a mixture of the constituent metal powders, while with atomised alloy powders it was not always possible to obtain compaction at all. Very fine powders were found to yield the best properties, but did not flow readily, and for commercial production would be unsuitable unless used in conjunction with some vibratory mechanism. For fine copper and tin mixtures the conditions likely to produce the best physical properties were indicated as being cold pressing at 30 tons per square inch, sintering at 800 deg. Cent. in hydrogen for thirty minutes, re-pressing at 30 tons per square inch and sintering as before. A number of brass and bronze components were illustrated and described, and their mass production with reference to die and press design was discussed.

In the next paper Mr. Bickerdike described experiments on the pressing and sintering of mixtures of aluminium powder with 6 per cent of copper powder. With a sintering temperature below the eutectic temperature the density increased with the compacting pressure at a gradually decreasing rate until the compact at 50 tons per square inch contained only very slight porosity after sintering. When sintering was carried out above the eutectic temperature the density first increased to a maximum and then decreased as the compacting pressure was raised. Pressure and sintering temperature had a critical effect on the properties of the sintered material. An alteration of 5 tons per square inch in pressure or 15 deg. Cent. in sintering temperature might produce a considerable change in tensile strength or density. Tensile strength and elongation values of 21·3 tons per square inch and 4·5 per cent respectively had been obtained with compacting pressures of 20 tons per square inch and at a sintering temperature of 575 deg. Cent., and indicated that it was not necessary to use more than moderate compacting pressures in order to obtain reasonably good tensile properties with small specimens.

Finally, there was Mr. Leadbeater's paper. So far as non-ferrous materials were concerned, the major interest in Germany, measured by tonnage, was in aluminium powder, which in flake form achieved an output of 13,000 tons per annum. It was obtained by atomising or disintegration of foil and afterwards pulverising in heavy, medium and fine stamping machines.

The equipment used in general was similar to that used in this country, except that certain improvements in design had been effected. Frequent screening was resorted to; one factory produced flake aluminium powder by ball milling, and satisfactory production was obtained by using paraffin wax instead of stearin as lubricant. Most of the flake aluminium powder produced in Germany had been used for armament purposes or in the chemical industry, but reference was made to the 90 per cent iron, 10 per cent aluminium mixture for the manufacture of heating elements, and another was cooking plates (made from a mixture of 80 per cent aluminium powder and 20 per cent alumina), which had heating elements attached to them, suitably insulated in shallow grooves. There were also brief references to the manufacture of copper powder by electrolytic methods and to de-icing parts made of copper in tubular form with a 70 per cent porosity, impregnated with ammonium chloride.

Discussion

Mr. J. W. Lennox (Sintered Products, Ltd.) said that the paper by Dr. Maurice Cook and Mr. Pugh showed a very nice die

design, and he would be particularly interested to know the type of clearance in the die which was used, because it was stated that all the flashes were removed from the compacts after pressing, which to him indicated that there was quite a reasonable clearance in the die during the compression.

Standardisation had been referred to a number of times and all the work had shown that slight variations in powder would give the fabricators of parts a great deal of trouble. He would again emphasise that the papers should give the origin of the powder, and that the various grades should be standardised and made such that both the user and the manufacturer could check on each powder.

Mr. R. Chadwick (I.C.I. (Metals), Ltd., Birmingham) said he found Mr. Bickerdike's paper extremely interesting, but was disappointed that he had not given the oxygen content of the powder, because another powder with a different oxygen content might have yielded results which were considerably different. In pressing aluminium powder with copper they had found that only with not more than about 0·1 per cent of oxygen could they get strong compacts, and even with as little as 0·25 per cent the strength of the compact was reduced very substantially.

He noticed that the strengths of the sintered compacts were given only after quenching and full ageing at room temperature. It would have been interesting to know what those strengths were in the quenched condition, and how much of that strengthening resulted from the age-hardening subsequently. The aluminium-copper system, of course, was subject to age-hardening, but that age-hardening was very greatly affected by the presence of iron as an impurity, and in an ordinary cast or wrought aluminium-copper alloy, according to the available information, a quantity of iron of as much as 0·28 per cent (which was the amount present in this particular sample of aluminium) would have been sufficient to reduce age-hardening to quite a low value.

He thought, too, that it might have been interesting if some of these materials had been examined by X-rays to get the lattice parameters. They had done some work on iron-copper and found that with 5 per cent of copper they could get a parameter corresponding to about 3 to 4 per cent of copper with about two hours sintering at 580 deg. Cent. He noticed that Mr. Bickerdike had used a very long period, something over twenty hours sintering, and that, of course, if one was thinking of commercial conditions, was longer than one could usually afford.

There were many other points which arose in connection with that paper, including the question of gas diffusion and gas evolution due to high temperature of sintering.

Mr. R. L. Bickerdike (Royal Aircraft Establishment, Farnborough), in reply, said that he had no information on the oxide content of the powder or on X-ray measurements. The increase in strength due to age-hardening could not be determined immediately after quenching, because machining of the tensile test pieces took rather a long time; so the specimens had been kept for a period of three weeks between quenching and testing, and the hardness and tensile tests were then all done within a very short space of time. In the absence of further experimental results he would not wish to deal with the complications due to gas evolution.

Mr. P. D. Liddiard (Glacier Metal Company), speaking on behalf of Mr. Tait, who was indisposed, said that Mr. Tait's paper brought out the value of powder metallurgy for dealing with immiscible materials, which normally could not be obtained in a suitable condition by casting methods. Powder metallurgy had provided a method for controlling the size and distribution, for example, of the lead in copper-lead alloys.

Some of the earlier efforts in that direction had been unsatisfactory because of residual porosity, and they had been dealing there with a bearing which did not require porosity.

The diagrams in the first appendix to Mr. Tait's paper were taken from work by Dr. Bowden, whose papers he commended to all who were interested in the subject.

Dr. Maurice Cook, in reply to Mr. Lennox, said that the clearance in their pressing dies was 0·001in. He was not clear as to what Dr. Lennox and others had in mind in referring to the source of the powder. It did not matter very much where a powder was made so long as information was given about the type of process used in its manufacture, and adequate details describing its physical and chemical properties and characteristics were recorded. It showed the need that had already been emphasised several times in the symposium for some kind of standardised procedure for examining, evaluating and testing powders.

The proceedings closed with a vote of thanks to those who had organised the symposium and to the Chairman.

Belgian Railway Bridge Reconstruction

By C. F. B. LEMAIRE, I.C.C., A.I.G.*

IN 1944 numerous bridges and other structures on the Belgian railway network suffered destruction or damage by aerial bombardment, sabotage or further to military operations. Further destruction was wrought by the German offensive launched by von Rundstedt in the Ardennes in December, 1944. The total effect was that no fewer than 466 bridges, comprising 395 railway bridges and 71 road overbridges, required either reconstruction or extensive repairs.

An emergency reconstruction programme was put into effect, with the result that early in 1945 45 bridges were repaired sufficiently to permit single-line working; 159 were replaced by temporary structures; and 44 were under reconstruction. This left 118 bridges yet to be restored. Then a further programme of work was carried out, with the result that by June, 1946, a total of 128

FIG. 1—STEEL CENTRING FOR HUY BRIDGE

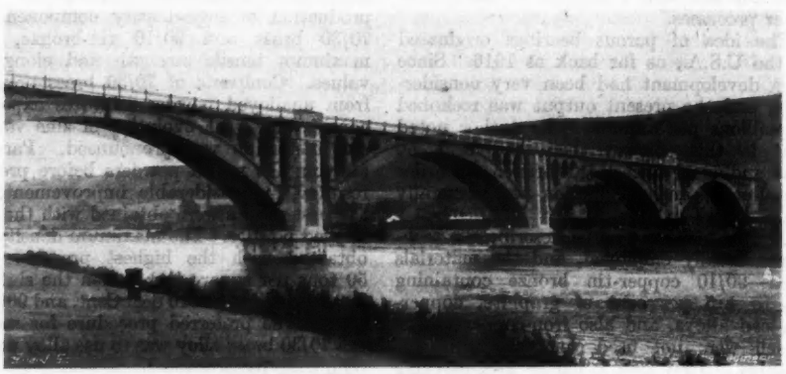


FIG. 2—RENORY BRIDGE AND VIADUCT, LIEGE

* Chief Engineer for Way and Works, Belgian National Railways.

railway bridges and 13 overbridges had been permanently restored and 242 bridges had been rebuilt temporarily. Of the remainder, 30 were under restoration and only 44 structures were still to be tackled; 305 of the restored bridges were rebuilt to carry the same number of tracks as before, whilst 60 were repaired only to the extent of providing single-line service.

It is therefore clear that much work was done in a short time, and it is greatly to the credit of the Belgian National Railways that such a measure of success has been achieved. But in spite of the satisfactory results of this work, many things remain to be done, and it is the opinion of the management that two years will elapse before there can be a return to normal conditions. The main difficulties to be faced are shortages of materials, particularly timber and steel, and shortage of manpower.

FIG. 3—DESTROYED SPAN OF RENORY BRIDGE

FIG. 5—BRIDGE OVER THE SCHELDE AT GHENT

FIG. 4—BRIDGE OVER THE BRUSSELS-CHARLEROI CANAL

Huy Bridge

Huy Bridge across the River Meuse was at one time a steel bridge of three spans carrying a double track. But the steel structure was replaced in 1921 by a fine stone bridge with three main arches, each having a span of 168ft. It was this bridge which was practically destroyed during the war, and which was rebuilt during the German occupation, forming a characteristic example of what was possible in spite of the occupation. The bridge is situated in a beautiful valley and faces the old city of Huy, dominated by an ancient citadel. A masonry arch bridge is therefore pleasing and in perfect keeping with the greyish tones of the site and surrounding cliffs.

When it came to restore the damage, stone and rubble were chosen for the structural repairs, because of the prevailing shortage of steel and cement. The choice of these materials also had the effect of utilising local workers in neighbouring quarries. A proportion of the materials from the demolished bridge was found to be serviceable, and was used again.

Huy Bridge was designed on classical lines, but the way in which it was restored was novel. The piers and abutments, founded on rock, were constructed from mass concrete, with a masonry facing. The arch vaults are of stone (petit granit), their thicknesses varying from 4ft 3in at the crown to 5ft 6in at the springings.

Before reconstruction was possible it was necessary to clear away much of the damaged structure and to salvage all material possible. *Débris* littered the bed of the river and had to be cleared by divers. Then the piers were repaired, within steel sheet pile cofferdams. In 1921 the piers were sunk by means of steel caissons founded on rock and filled with concrete, under compressed air.

Steel centring, each comprising four arched two-hinged trusses, spaced at 10ft centres and interconnected by transverse beams (Fig. 1) were used. Steel centring was chosen so as to be able to continue the work during winter floods and ice. The centring spanned the river from pier to pier, and therefore no supports in the river bed were required, which would have been carried away by ice.

The truss feet rested on a sand box, to take the vertical thrust reaction, and on an indented sector rolling on a rack for the horizontal thrust reaction. The outer trusses carried pillars supporting a crane gantry, and quick progress in the work of reconstruction was made by providing two travelling cranes with cantilevered arms, each capable of lifting a load of 7 tons from barges and placing it on the centring. In 1921 a cable crane was used, but with the equipment then installed only one lift could be made at a time.

Upon completion of the work the centring was removed by lowering it vertically by means of two specially built sand boxes. Each of these sand boxes consisted of a cylinder and a piston of cast steel, 18in in diameter. For economy, the piston was hollow and filled with concrete. It was fitted with a leather packing ring. The full stroke of the piston was 20in, and the cylinder was provided with six 1½in diameter holes for releasing the sand. Carefully dried fine white quartz sand was used, and it was found that the sand box could be loaded to more than 2100 lb per square inch.

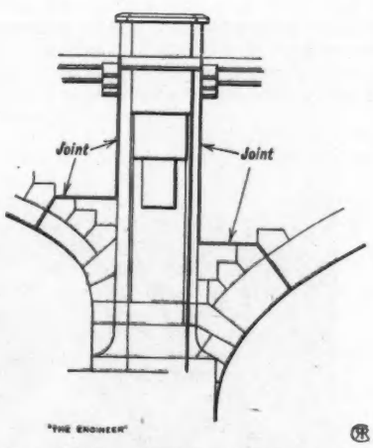


FIG. 6—ARRANGEMENT OF JOINTS AT PIER

Renory Bridge and Viaduct, Liege

Renory Viaduct comprises nine arches, each of 204ft span, and an approach span of 112ft, the total length of the structure exceeding 2300ft. The decking, 65ft above ground level, is 26ft wide and carries double railway lines and two footpaths, the latter being

supported by precast concrete brackets. The viaduct crosses the River Meuse, near Liége, and carries the railway over the river harbour of Renory. It is built in plain concrete, with three-hinged arches. The three-hinged arch was chosen because of the likelihood of ground subsidence in the vicinity, which is a mining area, and concrete was chosen in preference to steel because steel structures become heavily corroded in a short time in the Liége atmosphere of smoke and acid fumes.

Taking into consideration its length and height, the viaduct (Fig. 2) has a pleasing appearance, due to a balance of masses. The lines are simple, the concrete where visible is smooth (but received no special treatment), and its greyish tone harmonises with the surroundings. The pillars are faced with sandstone, with stone string courses. The steel hinges are visible and accentuate the character of the structure.

When the Germans invaded the country in May, 1940, Belgian Army engineers destroyed one span (Fig. 3), in order to cut the main Brussels–Liége line. During enemy occupation this arch was rebuilt, and although it has the same appearance as the original, it is lighter, due to internal hollowing.

Reinforced concrete was used for rebuilding the demolished span, and steel centring similar to that used for the Huy Bridge was erected. The river bed was littered with rubbish, which was impossible to dredge, so it was necessary to use explosives and make underwater examinations by divers. The plant used by the contractors included a floating winch and pontoons with steam cranes. The pier was rebuilt inside a steel sheet piling cofferdam, and material was satisfactorily handled by a cable crane.

Bridge Over Brussels–Charleroi Canal

In Fig. 4 is shown nearing completion the reconstruction of a double-track railway bridge on the Bussels–Ostend line, spanning the Brussels–Charleroi Canal. This bridge, with an overall length of 230ft, has a bow-shaped central arch with a span of 132ft and a rise of 26ft. The whole structure is in reinforced concrete.

It was completely demolished in the course of hostilities early in 1940. Rebuilding was started on August 13, 1940, and was completed on October 2nd in the same year. The photograph reproduced shows the timber centring and trestles used during the rebuilding. Only a narrow navigable channel was left during the work. The bridge was rebuilt in reinforced concrete with a brick facing.

Bridge Over Schelde at Ghent

This bridge is on the Brussels–Ostend line, at the entrance to the City of Ghent. It was destroyed in May, 1940, but permanent rebuilding is now nearing completion. The structure is in concrete, with a central navi-

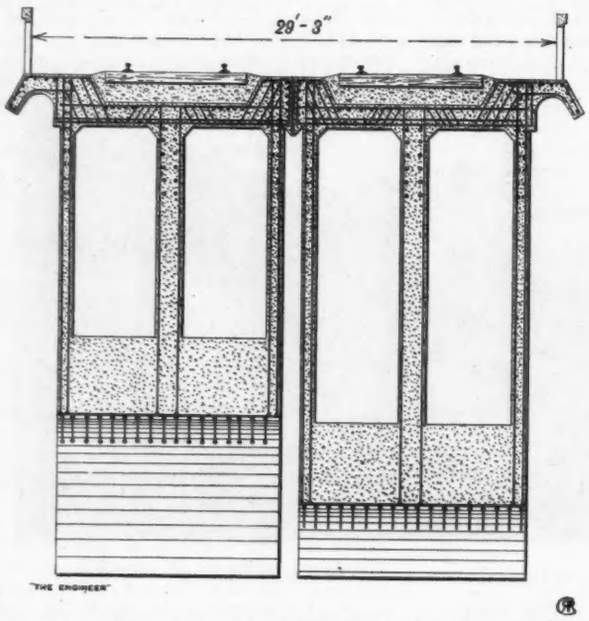


FIG. 7—SECTION THROUGH CONCRETE BRIDGE NEAR CHARLEROI

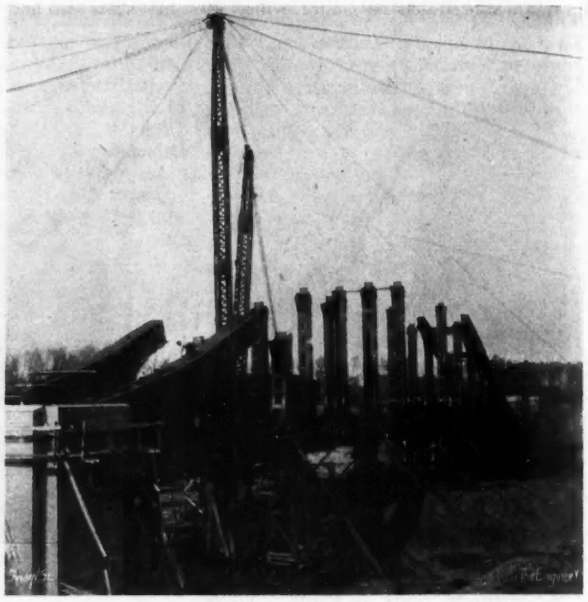


FIG. 9—BRIDGE AT GELLIK UNDER CONSTRUCTION

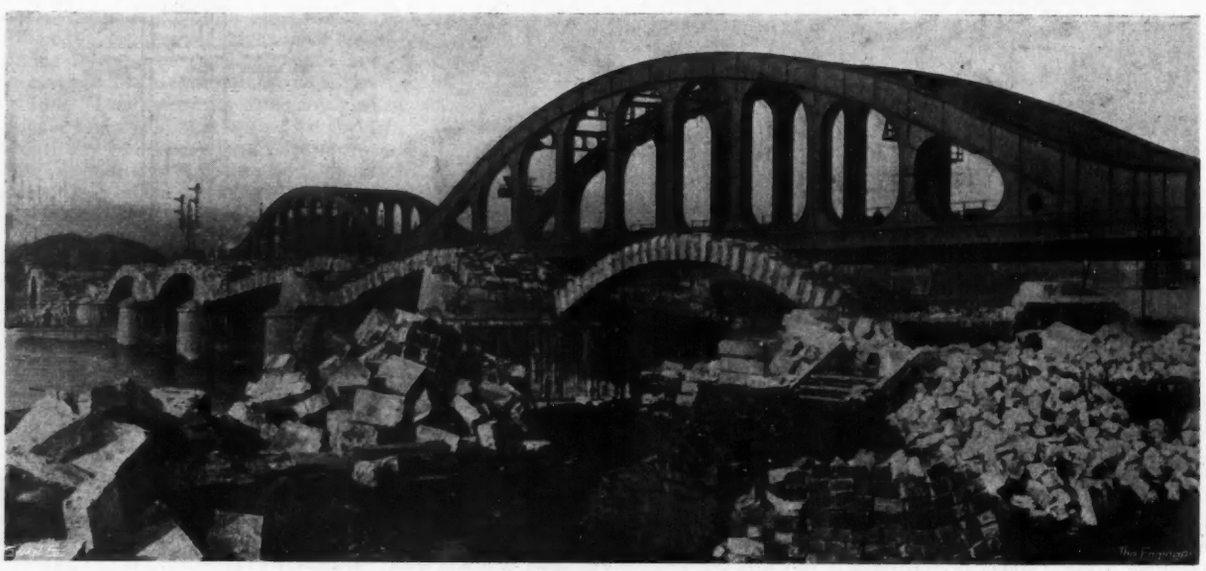


FIG. 8—VAL-BENOIT BRIDGE OVER THE MEUSE AT LIEGE

gation span of 88ft (Fig. 5) and two side spans, each of 49ft. It carries four sets of lines and the decking is 56ft wide, not counting a 7ft 6in footpath cantilevered out from each side of the bridge. For appearance the bridge is faced with brick and masonry.

The piers and abutments of the original bridge were founded on piles. The violence of the explosion which wrecked the structure reduced the concrete to powder, and it was found necessary to remove the old concrete and make a new pier foundation on a concrete slab, 20in thick. In the rebuilt structure three-hinged arches (Figs. 5 and 6) were used, instead of fixed arches, so as to allow for movement. In order to reduce the dead load on the springings, the arches are provided with a reinforced concrete "lightening" slab, 20in thick. The hinged joints, shown in the sketch, Fig. 6, are arranged at the crown and springings, with the local concrete strengthened by an increase in the cement ratio of the mix. The bridge was erected in three stages, as it was at all times necessary to leave in service three out of the four tracks.

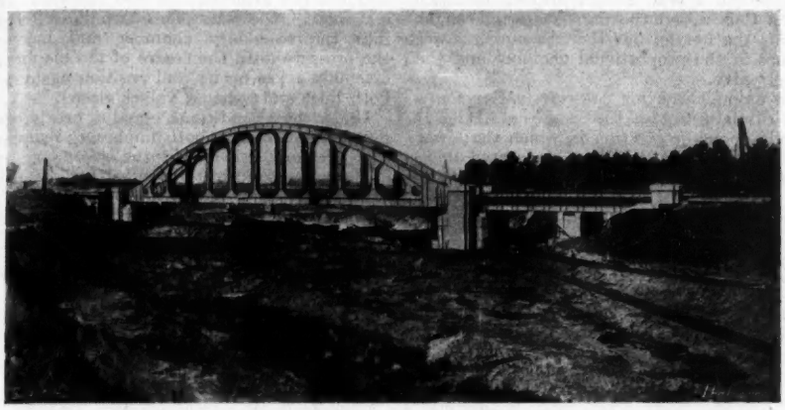


FIG. 10—BRIDGE AT GELLIK COMPLETED

CONCRETE BRIDGE NEAR CHARLEROI

Shortage of steel and the high cost of labour made it necessary to rebuild many railway bridges in reinforced concrete, even when they were on lines carrying heavy traffic. Several of the slab type, with spans up to 100ft, have already been completed or are in course of construction.

One of the more important structures is the reinforced concrete bridge near Charleroi on the Paris–Liége line. The original bridge was designed on principles laid down by the famous French engineer, Freyssinet, and was completed in 1922. It crossed the River Sambre at an angle of about 45 deg., and had a span of about 192ft. Instead of skewed arches, two straight arches were used, each carrying a single track.

The bridge was rebuilt in 1940–41. Considerable bending moments were involved, because of the length of the span and the heavy loading. The rise is nearly 20ft. In Fig. 7 is reproduced a cross section through the structure, which comprises a decking slab connected to the arch rib by solid reinforced spandrels. The design is very economical of material and at the same time is strong enough at the springings to resist the bending moments. The spaces between the decking and the ribs near the springings were filled with mass concrete, in order to absorb vibration. The arch is double-hinged, with the type of hinge in which two cylindrical surfaces, of slightly different radii of curvature, roll on one another.

STEEL BRIDGES OVER THE ALBERT CANAL

Between Antwerp and Liége there were before the war several railway bridges crossing the Albert Canal, with spans varying from 165ft to 370ft. They were all destroyed by the Belgian Army in 1940, and are at present being rebuilt.

The Gellik Bridge is perhaps the most important of these structures. It is illustrated in Fig. 10 as it appears now that it is completed, and in Fig. 9 during erection. It carries a single track on three spans, of which the main Vierendeel span is 370ft long. The side spans are of the girder type and are each 108ft long. The central span, the longest in the world of its type, has upper chords of parabolic shape, with a rise of 51ft, and with a box-shaped cross section for all members, which are riveted together. The box section is sufficiently large to permit a man to crawl through when maintaining the bridge. Welded construction was adopted for the side spans. Their main girders are 8ft 9in high. In the contract 1370 tons of steel and 9400 cubic yards of concrete, reinforced and plain, for abutments, foundations and retaining walls, were used.

Among other railway bridges being rebuilt over the Albert Canal may be mentioned the Genk–Langerloo Bridge, comprising two riveted lattice girder spans of 171ft and 202ft; a similar structure known as the Curange bridges, formed by two spans each of 235ft; and the three-span Kwaadmechelen Bridge, again similar as regards the 235ft central span, but with the side spans of welded construction. Finally, there is the Herenthals Bridge, three spans of 110ft, 290ft, and 110ft respectively, the central span being of the Vierendeel pattern. Here again the members are of box cross section, large enough to permit internal maintenance work by a man.

VAL-BENOIT BRIDGE, LIEGE

The Val-Benoit Bridge across the River Meuse carried a double-track line from Liége to Aachen and Cologne, in Germany. Work in progress on the reconstruction of this bridge is shown in Fig. 8. The new bridge consists of a central riveted steel span of the Vierendeel type, 283ft long, and two side girder spans, each about 214ft long.

Before its destruction in August, 1939, the Val-Benoit Bridge was a double structure, of which each half carried one railway track. In preparation for invasion Army engineers placed explosive charges, which, it appears, were inadvertently detonated by an induced electric current set up by a heavy storm. All six spans were destroyed. Examination of the broken members indicated that where the mild steel structure was broken by the direct explosive action the fractures showed no contraction in area, just as if the steel were a brittle material, but away from the neighbourhood of the explosions the steel was bent to angles of 180 deg., strained by buckling and rivet holes were elongated, as is expected with a ductile material.

The destroyed bridge was completed in 1937 and replaced an old stone viaduct, which consisted of five arches, each of 65ft span. This stone structure dated from 1839, when the first railway was built from Belgium to Germany.

An Air Operated Automatic Controller

A NEW automatic control instrument has been developed by George Kent, Ltd., of Luton, for application to a large number of processes in conjunction with the standard measuring instruments used for temperature, flow, specific gravity, pressure, &c. Known as the "Mark 20" controller, it is designed to perform the following kinds of control: proportional, floating and proportional, proportional and first derivative, and floating plus proportional plus first derivative.

The instrument operates on a system in which a deviation from the desired control point causes a variation in air pressure being transmitted to a control valve which is acting as the means of regulating the plant to be controlled. With it, integrating times between ten seconds and twenty minutes are possible, with infinite adjustment between these extremes. Proportional band setting can be varied from ½ per cent to 650 per cent and a clear scale is provided for this purpose. The range of adjustment for the derivative function is in the order of 120 to 1. The control mechanism is designed to detect a deviation of less than 0·2 per cent of the maximum scale reading and will move the regulating device accordingly. To operate the instrument, three cubic feet of free air per hour at any pressure between 20 lb and 100 lb per square inch is required. Air consumption, naturally, increases with the magnitude and frequency of the disturbances which the controller is called upon to correct.

One of the new control instruments can be seen in Fig. 1 fitted to one of the firm's ring-balance meters for the measurement and recording of low pressure air or gas flows. The two main components are the control mechanisms, a photograph of which is reproduced in Fig. 2, and a power relay unit, to be seen on the right of the instrument, Fig. 1.

The control mechanism embodies a measuring and setting pointer differential gear, a proportional sensitivity adjuster, a bellows unit, and a nozzle gear, which, as can be seen from the drawing, Fig. 3, are all combined into one compact unit. The controller incorporates a differential mechanism in the form of two U-shaped members, A and B. The member A is pivoted to the framework of the mechanism midway along its length, and its right-hand extremity is connected through links to the setting pointer of the measuring instrument. Member B is pivoted to member A at its left hand extremities and is connected through links at its opposite end to the measuring instru-

ment's pointer. This member also has two pivot holes midway along its length. When the measuring pointer and the setting pointer of the measuring instrument are coincident, these pivot holes are opposite the pivot point of the member A, irrespective of the position of the instrument pointers on their scale. If the two pointers separate, however, the pivot holes in

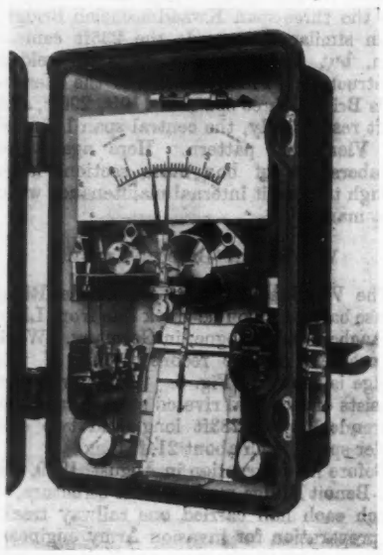


FIG. 1—CONTROLLER FITTED TO RING BALANCE METER

the member B rise or fall a proportional amount with respect to A.

The pivot holes in B carry the left-hand extremity of an inverted tee-shaped frame C, which is in effect a floating differential link. The right hand end of this frame is connected through a link to one arm of a bell crank D, the position of which is dependent upon the difference in pressure existing on either side of a bellows E in a chamber in the lower body of the unit. Pivoted to the upper part of the frame C is a lever F the lower end of which describes an arc which passes through the central pivot points of the member B, and the pivot

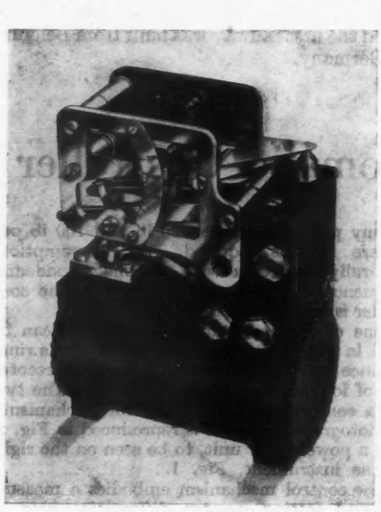


FIG. 2—CONTROL UNIT

of the interconnecting link to the bell crank D at the opposite end of the frame C. Attached to the lower end of F is a link G, which transmits any movement to a nozzle lever assembly above. Through an adjustable pointer lever H the angular position of the lever F can be adjusted over a wide arc in respect to the member B.

It will be appreciated that if the differential members A and B are displaced for any reason and cause the left-hand end of the frame C to fall, it will initially cause the nozzle link G to rotate the nozzle lever about its fulcrum in an anti-clockwise direction. This movement lifts the nozzle flap and allows air to escape with a resultant reduction of pressure in the tube behind the nozzle. Air pressure behind the nozzle acts on the primary side of a relay, the secondary side of which transmits a similar pressure to the proportional side of the bellows and to the control valve. This reduction in pressure allows the bellows to expand and causes the bell crank D, passing through the diaphragm J, to rotate about its fulcrum K and raise the right-hand extremity of the frame C. As C is raised the flap is again brought towards the nozzle, but there is now a lower pressure in the proportional chamber and the control valve.

The amount the air pressure varies for a given displacement of the members A and B depends upon the position in which the lower pivot point of the nozzle link G is located along the base of the frame C. For instance, if it were in the middle, *i.e.*, with the link vertical, as shown, the amount of movement resulting at the right-hand extremity would be equal to the displacement at the centre of the members A and B.

The floating control function is obtained by allowing the air in the proportional side of the bellows chamber to leak through a suitable adjustable needle valve resistance to the other side of the bellows, and so permit the control pressure to continue to rise or fall if the differential members are separate, *i.e.*, if the instrument is off its control point. The rate at which the control pressure varies for a given displacement of the differential member depends upon the value of the floating throttling resistance and is proportional to the control error or separation of the two pointers on the instrument.

When derivative function is required, an additional throttling resistance is included in the connection between the relay and the proportional chamber, so that the "follow up" effect of the bellows is delayed. In this case the pressure at the relay secondary and control valve will be greater than that existing in the proportional chambers while the error or deviation from the control point is changing, due to the pressure drop across the throttling resistance. This value is dependent upon the rate at which the control error is changing.

In order to keep air consumption to a minimum, and so as not to restrain the measuring instrument to which the controller is connected, the control nozzle has a very small bore. This nozzle deals with extremely small quantities of air, which would take too long to change the position in the control valve if a relay were not employed. The relay, which has been developed for this controller, is combined with a reducing valve, a nozzle throttling resistance and an auto-manual selector valve. The relay consists of two diaphragms, mechanically connected at their centre. The pressure from the nozzle is connected to a primary diaphragm chamber, so that there is a force proportional to this air pressure acting on a second diaphragm through an attachment between the two diaphragms. This second diaphragm has a small hole in its centre which is normally covered by a needle valve but which, when open, permits air to escape from the secondary diaphragm chamber to atmosphere through the space between the two diaphragms. The needle valve carries a second cone which locates in a seat arranged in the air supply connection to the secondary diaphragm chamber. When air pressure increases in the primary diaphragm chamber, the resulting force moves the diaphragm centre assembly in a direction which will cause the exhaust end of the needle valve to close the exhaust hole and raise the inlet end cone off the seat. This permits air to pass into the secondary chamber and increases the pressure until the centre of the diaphragm assembly takes up its null position again with both inlet and exhaust valves closed.

Under these conditions, equal or nearly equal pressures will exist in both diaphragm chambers. The pressure existing in the secondary side of the relay is led to the control valve and the proportional side of the bellows chamber in the control mechanism, or in the case of the derivative controllers, to the derivative resistance throttle valve.

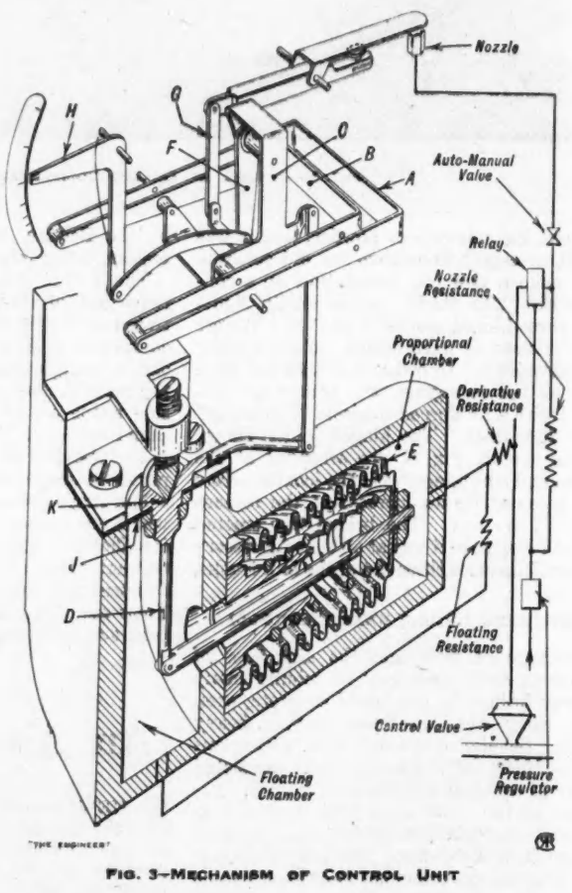


FIG. 3—MECHANISM OF CONTROL UNIT

A pressure regulator fitted to the instrument is arranged to reduce the supply air to a standard pressure of 17 lb per square inch when operating on automatic control or to any pressure between 2 lb and 12 lb per square inch, when operating on manual control.

A nozzle resistance in the form of a short length of capillary tube carried in a suitable mounting is designed to restrict the flow of air to the control nozzle. The mounting is made readily accessible so that it can be removed and, if necessary, a new capillary fitted if it should at any time become choked.

An auto-manual selector valve in the connection between the nozzle throttling resistance and the nozzle renders the controller inoperative during manual control, when the position of the control valve is regulated by the manipulation of the pressure regulator hand wheel. The throttle range adjuster H indicates on a scale mounted on the controller mechanism.

It is scaled in percentage of meter pen travel necessary to cause the control air pressure to change through its full range of from 2 lb to 12 lb per square inch. Reducing the scale reading increases the proportional sensitivity.

The floating and derivative throttle resistance valves are provided with micrometer adjusting means. Opening the floating needle valve increases the floating sensitivity, *i.e.*, increasing the rate of re-set. Opening the derivative valve decreases the amount of derivative effect. Both valve micrometers are scaled in degrees of needle travel.

In designing this instrument the maker has taken much trouble to eliminate waste of time in maintenance or repair. The controller is designed for quick and easy replacement by a spare unit, without disturbing the measuring instrument itself should occasion arise. Only two pivot screws are used in the whole of its mechanism and the various links and levers are held on their pivots by means of sliding spring clips. In a recent demonstration of the instrument we were shown how the whole of the lever assembly could be taken down in little more than a minute and without the use of a single tool after four screws had been removed. When necessary a new part can be introduced and the mechanism re-assembled in a relatively few minutes.

65-B.H.P. Mines Diesel Locomotive

A NEW 65 b.h.p. flameproof diesel locomotive for underground service in coal mines which has recently been introduced by the Hunslet Engine Company, Ltd., of Leeds, is now being built in increasing numbers. This engine supersedes the company's 50 b.h.p., four-wheeled locomotives for coal tub haulage and man-riding service, and is intended specifically for hauling the small capacity, high resistance tubs used in a majority of the pits in this country. In many of these older pits the introduction of locomotive haulage is something of a problem in view of the physical restrictions imposed by curves, gradients, loading gauge and axle load. The new locomotives are intended to enable the modernisation of haulage to be effected without the necessity for making extensive alterations to the working of existing equipment of such pits.

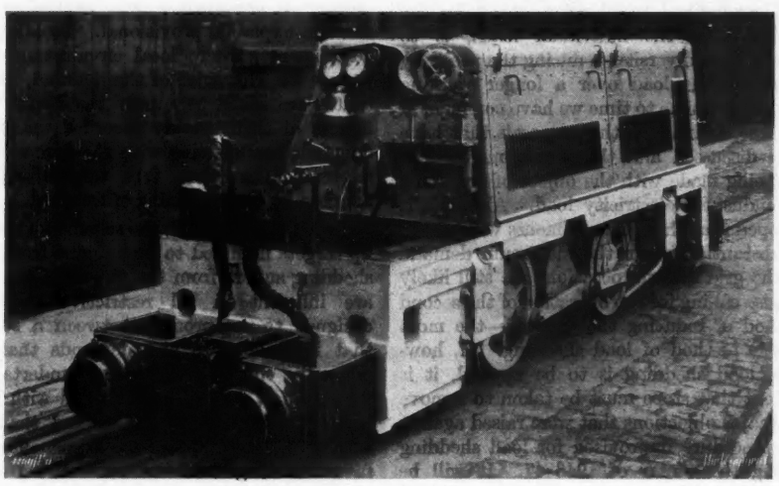
MINES' DIESEL LOCOMOTIVE

We recently had an opportunity to inspect one of the new locomotives. Two photographs we reproduce on this page show its general appearance.

The locomotive can be built to any gauge from 2ft to 3ft 6in, and its weight of 10 tons is equally distributed over the four wheels so that it can work on 35 lb rails, or 28 lb sections can be used if the sleeper spacing is close. With a wheelbase of 4ft 3in the locomotive has a length of just under 13ft over buffer beams and an overall width of 3ft 10in. Curves of 40ft radius can be negotiated by a locomotive alone, but tub and drawgear movement considerations make a greater radius necessary when a train is attached. Curves of 75ft are a widely accepted minimum when large cars are being hauled. The working in many pits has shown that a factor of adhesion of 4·25 to 1 is the minimum that will give satisfactory performance. In order that the new locomotive shall give the best practical results with small tubs an adhesion factor of 5 to 1 has been adopted, for it is considered that very few tub drawgears could withstand the pull of 5250 lb resulting from a 4·25 to 1 factor. The power thus has been made useful at the upper part of the speed range rather than being used to overstress drawgear at low speeds.

With its weight of 10 tons the locomotive is used for man-riding trains fitted with Westinghouse air brakes complete safety of operation is ensured on the steepest gradient of 1 in 12 which is envisaged in the Model Code of Regulations.

Power is provided by a Gardner "4 L.W." engine giving 65 b.h.p. at 1700 r.p.m. It is mounted directly on the frame structure and is arranged to drive an air compressor and the radiator fan through belt pulleys at the front. Engine starting is effected by a Reavell rotary air motor operating through Bendix gear, and hand starting gear is provided at the front of the locomotive. Normally, the starting motor is supplied with air from a point in the mine air line, but when a locomotive is fitted with Westinghouse brake gear starting air can be obtained from the brake reservoir.



DRIVER'S CAB AND CONTROLS

Drive is transmitted to the gear-box through a friction clutch, of the maker's own design, in which a series of deflector plates is arranged to induce a flow of cooling air between the plates when the clutch is disengaged. A two-speed gear-box is designed to drive the locomotive at speeds up to 4½ and 9 miles an hour, the tractive effort at 4½ m.p.h. in first gear being 4500 lb, and at 9 m.p.h. in second gear 2250 lb. This top speed is all that is possible in many workings and the higher engine output compared with the maker's older locomotives enables the two-speed box to give a road performance equal to existing types having three or four-speed gear-boxes. The jackshaft driven from the gear-box is set between the two pairs of wheels and from it drive is transmitted to the crankpins through two short independent rods on each side.

An exhaust conditioner of the water-washing type is fabricated throughout of stainless steel and, together with the stainless steel flame traps, is fitted within the frame at the front of the engine. Similar flame packs and A.C.-Sphinx oil-bath air filters are fitted to the intake manifolds of the engine. A radiator at the front of the engine is composed of Serck interchangeable sectional elements for water and oil secured to fabricated steel headers and frame.

The basis of the locomotive is a single casting of high-duty iron, weighing some 5½ tons, which embraces the whole main frame structure, the top portion of the gear-box and other details. The locomotive has bronze axle-boxes with Armstrong oilers and laminated springs of silico-manganese steel, all of the gears being of case-hardened nickel steel mounted on involute splines. In order to simplify and speed up production the engine is designed on the unit principle, and, other than its main castings, beams and axles which are made specially to suit the various rail gauges, the whole range of components is designed for manufacture on a modified line production system.

Particular attention has been paid to the arrangement of the driver's cab to give means of quick and easy control, comfort and good visibility. The driver sits in a padded corner seat with all the control levers within easy reach, and inset head and rear lights are designed to throw a powerful beam in the direction of travel. A small transmission brake is automatically applied on disengagement of the clutch to stop the gears when changing up, and the air starting gear is interconnected with the gear lever so that it can only be used when the engine is in neutral. The brakes, which are normally applied by hand, incorporate additional pedal means of operation.

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AUGUST 22, 1947

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

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LOAD SHEDDING

BROADLY speaking, there are two methods of reducing the maximum demand upon generating stations connected to the grid. The first method, which need not involve any reduction of the individual loads, is to improve the diversity, reducing the peaks by spreading the load over a longer working day. From time to time we have commented in these columns on the proposals that have been discussed and the arrangements that are being made with the object of spreading the industrial electricity load. Although it is hoped that these arrangements will lead to a substantial fall in the maximum demand on the grid system, occasions are still likely to arise calling for the operation of the second method of reducing the demand—the more drastic method of load shedding. If, however, load shedding is to be applied, it is evident that steps must be taken to remove the major objections that were raised against the procedure improvised for load shedding during the winter of 1946–47. It will be recalled that owing to the rapid rise of load at times of maximum demand it was frequently necessary for the Central Electricity Board to issue instructions for load shedding when the frequency was yet little below normal, so as to ensure that the anticipated fall in frequency would be arrested before the danger limit of 48 cycles per second was reached. Under such conditions there could be no adequate warning of the approach, duration or magnitude of the cuts. In the absence of any indication of their permissible maximum loads undertakers were unable to make any effective arrangements with their consumers to minimise the industrial dislocation caused by sudden load shedding with the attendant risks of danger to operatives and damage to machinery.

Various schemes for removing these difficulties have been considered during recent months by the C.E.B. in conjunction with the Electricity Commissioners and the Electricity Supply Joint Committee. These discussions have now resulted in the evolution of a plan, approved by the Ministry of Fuel and Power, whereby each undertaker will be given, as a target, a maximum demand to which he will be required to reduce his load when called upon by the C.E.B. Details of this plan are disclosed in the Board's memorandum which accompanies a circular letter, dated August 16th, from the Electricity Commission to all authorised undertakers. The memorandum explains that, in the all-important task of calculating the targets it was necessary to ignore any statistics and estimates that were influenced by the abnormal demands associated with the fuel crisis. Undertakers were therefore asked by the Board for information about the percentage of the peak loads in November–December, 1946, attributable to the three main groups of consumers—public lighting and traction, industrial, and general—together with an estimate of the anticipated additional industrial load for the 1947–48 winter. Making due allowance for diversity the Board then estimated that the plant capacity available in the critical month of January, 1948, would be capable of supplying individual targets amounting in the aggregate to 9,472,000kW. From this information the Board apportioned to each undertaker a target maximum demand for January, 1948, with correspondingly lower targets for other months in which less generating plant will be available. The targets thus calculated for individual undertakers are, as the memorandum explains, provisional. To allow for adjustments, where local circumstances influence the character of the demand, undertakers are asked to supply the Board with figures of their weekly recorded maximum demands commencing with the first week in September, so that firm targets can be adopted by the beginning of October.

Considered in detail, the scheme for setting up targets intended to be immune from load shedding suffers from the imperfections that are inherent in all restrictive measures designed to compromise between a supply that is inadequate and demands that are mutually competitive. Some undertakers, for instance, may feel dissatisfied with their individual targets on the ground that the industrial load appears to be penalised in favour of the general consumer. It is reasonably argued in the memorandum, however, that the relative assessment of the industrial and general loads in calculating the targets represents an equitable balance between somewhat imponderable estimates. Generally, when this scheme is implemented, undertakers will have the advantage that they lacked a year ago, of being able to draw up a programme, suited to local conditions, for reducing the load, when required, to the stipulated targets. One such programme that has already been operated successfully is based on the establishment of a rota by subdividing the distribution network into, for example, five sections, which can be "shed" daily in rotation. On any particular day of the week, therefore, load shedding, if it is required at all, will be confined to a certain section which can reasonably expect immunity on other days. This necessity for stabilising as far as possible the industrial consumers' supply inspires the hope that, once undertakers' targets have been firmly established, no contingency will arise to enforce reductions below the target level. For the success of the scheme will largely depend on the extent to which the targets' immunity can be preserved.

THE ENGINEERS' GUILD

WE have always watched with close attention the progress of the Engineers' Guild and now observe with satisfaction a momentous change in its affairs. The Guild was founded some years before the recent war to do for engineers things that the great institutions cannot do. By the terms of their charters those institutions must confine their activities to the science and practice of engineering and must not concern themselves with the personal interests of their members. Such matters as status, fees, salaries and so on are outside their field. That is as it should be. No one who has at heart the true interests of the great institutions as the leaders and reporters of progress in all branches of the science and technology of engineering would desire to see it otherwise.

At the same time, it cannot be denied that in this modern world engineers do require an organisation that looks after affairs associated with their personal professional interests. Such a body is the Engineers' Guild, which has bravely kept itself in existence through the trials and disturbances of the war. Since its inception the major institutions have looked upon it not without sympathy, but with hesitation, if not, sometimes, with actual suspicion. Their fear was that it intended to introduce the methods of trade unionism into professional engineering. Whether or not that would be a bad thing in these days is a matter of opinion. In any case the Guild has always maintained that it can and does conduct its business without the application of trade union methods. However that may be, we now notice that certain eminent members of the three major institutions have decided that the time has come when they should take an active part in directing the activities of the Guild. This development is shown by ballot papers for "General Representatives" on the Council of the Guild, which are now before the members for return before September 1st. The list of candidates, ten in number, of which seven are to be chosen, is wholly composed of engineers holding high positions in the great institutions—past presidents, vice-presidents and members of Council—and/or members filling important posts in engineering circles.

The result of the election of seven such "general representatives" must clearly be

to bring about a closer association between the great institutions and the Guild than has existed in the past. What other effects may follow it is too soon to forecast, but at any rate engineers no less than the Guild itself are to be congratulated upon a step, taken cautiously after years of consideration, which cannot fail to be of direct benefit to them in their profession.

Obituary

J. FOSTER KING, C.B.E.

We greatly regret to record the death, in Glasgow on August 11th, of Dr. J. Foster King, who for over fifty years was actively associated with the work of the British Corporation Register of Shipping. For thirty-six of those years he was Chief Surveyor to the Corporation, in which position he made some notable contributions to naval architecture and shipbuilding.

James Foster King was born at Erskine in 1862 and was educated at the Glasgow High School. His apprenticeship began with Russell and Co., of Port Glasgow, when he was about fifteen, and a few years later he was put in charge of the drawing-office when the firm opened its new yard at Greenock. From there he went to the drawing-office of Messrs. Earle's shipbuilding yard at Hull, and subsequently to Harland and Wolff, Ltd., at Belfast, where he took charge of a separate drawing-office which was concerned with the building of the "Majestic" and the "Teutonic."

When the British Corporation Register of Shipping was founded in 1890, Foster King was appointed Principal Surveyor under Professor Jenkins. Later, he became Assistant Chief Surveyor under Mr. Courtier-Dutton, whom he succeeded as Chief Surveyor in 1904. It may justly be said that there are probably very few merchant ships to-day which do not show in their construction some traces of Dr. Foster King's influence in the development of ships' structures. Freeboard regulations and the basic principles underlying them were among his special interests, and his knowledge of the subject has been recognised both nationally and internationally, as also has his work on the Bulkhead Committees from 1912 to 1915 and in 1923–24, on which the main requirements of the International Convention of 1929 are based. At the International Conference on Safety of Life at Sea in 1929 and at the Conference on Load Lines in the following year, Dr. Foster King was a prominent member of the British Government delegation. He retired from the position of Chief Surveyor of the British Corporation Register in November, 1940, and in recognition of his outstanding services was elected an Honorary Member of the Corporation.

Dr. Foster King contributed many papers to the proceedings of technical societies, both in this country and overseas. He was an Honorary Vice-President of the Institution of Naval Architects, an Honorary Fellow of the North-East Coast Institution of Engineers and Shipbuilders, and an Honorary Member of the Institution of Engineers and Shipbuilders in Scotland. He was also a member of the Society of Naval Architects and Marine Engineers in America. The honour of C.B.E. was conferred upon him in 1920, and the University of Glasgow recognised his attainments by bestowing upon him the degree of LL.D.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE FIRST CAST-IRON BRIDGE OVER THE SEVERN

Sir,—The announcement in your issue of August 8th regarding the new Severn Bridge prompts me to refer to another bridge over the same river—the famous Iron Bridge at Coalbrookdale.

How many of your readers, I wonder, may be aware that this historic structure—which is reputed to be the first cast-iron bridge ever erected (it was opened in 1779), and which is scheduled as a National Monument—is now closed to vehicular traffic? My informant, who visited the bridge earlier in the summer, described it as being sadly dilapidated in appearance.

The late war swept away many of our ancient monuments and a spirit of "Up with the new, down with the old" seems to be widespread to-day. But it is to be hoped sincerely that neither the difficulties of maintenance occasioned by shortages of labour and materials, nor an indifference to the works of an earlier generation of inspired engineers, will be allowed to jeopardise the preservation of a structure which was once (as the Torrington Diaries ingenuously put it) "the admiration as it is one of the wonders of the world."

John Wilkinson championed the adoption of cast iron for the construction of the bridge; Abraham Darby the Third cast the great members in the Coalbrookdale works; Thomas Telford, twenty years later, drew lessons from it when preparing to build the first of his own iron bridges.

These seem good reasons why the responsibility for maintenance might be put forward as a matter of national rather than parochial or county interest.

J. W. Butler.

London, W.2, August 13th.

"SCIENCE, LIBERTY AND PEACE"

Sir,—It seems clear that Mr. Taylor and I are to some extent arguing at cross purposes, and that we may, in fact, have some measure of common opinion. Perhaps it would be as well if I, too, clarified my position.

Mr. Taylor essays upon our "troubles," but avoids defining them. He then joins issue with anyone who knows what is wrong with present conditions or how they should be cured, because he fails to see any signs that we have the ability to make the best of what we have.

Mr. Taylor may join issue with anyone—and, heaven knows, he will be kept busy—but before he can judge them right or wrong, he will be obliged to have others accept *his* yardstick. That surely, is precisely why no one can agree on the meaning of our troubles. Mr. Taylor is therefore begging the question.

Mr. Taylor attempts to absolve the technician from his considerable responsibilities in the matter of our present "troubles" by asserting the nature of present events to be predetermined. This is merely to provide men with a scientific justification for the exercise of power without responsibility, or to deny them responsibility for any other actions.

He speaks also of making the best of what we have, but fails to define the ends to which "best" applies. Of course, it is true that our present environment is the result of a causal chain reaching down through time immemorial. It is likewise a truism that everything around us is a complex swirl of electronic forces. Truth on one plane, however, may be an absurdity on another. As men, we have to decide which causes and necessary actions appear the most relevant to the problem before us (which needs to be better defined than as "trouble"). Our interpretation of causes and any necessary actions will be determined by the nature of our beliefs. If we consider the problem accessible by scientific truths, we interpret and act accordingly. If not, we act in accordance with other beliefs. In applying scientific methods we are always placed at a disadvantage by our lack of a complete knowledge of contributory causes. Scientific method is based on the axiom that by detached and detailed research man will eventually unravel the causes leading to any given problem, and therefore be able to predict the outcome of any given action. If our "problem" is of this nature, then we are justified in believing that by detached observation we shall acquire "wisdom" (or belief) in dealing appropriately with it. History shows, however, that all men have never held a common belief for long—if at all—and it is equally certain that they never will. Unless, therefore, a society is prepared to tolerate a particular belief, the holders of that belief must either fight for a tolerance of all beliefs or attempt to establish their own autocracy. The historical picture is a record of the transition of power from one group of sincere fanatics to another.

If one does not believe that the "condition" of man is amenable to scientific diagnosis and cure, and the predominant or implied belief and subsequent framework of society insists that it is, he must either fight for his own beliefs and way of life or learn to live "wisely" whilst he becomes the subject of a vast pseudo-scientific experiment. What, then, if one's attempt to live "wisely" conflicts with the "ignorance" of the totalitarian authority? Quisling or concentration camp?

The issue is eternal, for man must live according to his real beliefs (conscious or otherwise). Mr. Taylor's wisdom will begin, not when he learns to live "wisely" under "come what may" (living wisely may mean dying wisely), but when he sees the one cause worth supporting is one based upon the toleration of all beliefs, *i.e.*, upon the liberty of the individual. The preservation of this liberty is our sole guarantee against widespread violence and misery.

Democracy requires a common acceptance of this "agreement to differ." This agreement can be accepted, it would seem, only when all men are fully enlightened, or when the mass of people are fighting for their own beliefs against an autocracy sufficiently enlightened to grant them democratic powers. As the tree shall be known by its fruits, one must conclude that the majority of men have a greater belief in the validity of "machines," "money" and "progress," as redressers of their condition, than they have in any other belief. This being so, the necessity for the liberty of the individual appears at first redundant and then a positive obstacle in the way of "progress."

The gods of "machines," "money" and "progress" have, of course, in previous ages existed in other forms. People now accept these contemporary gods because their power is evident and tangible, for people only really believe in what they see. An abstraction has no meaning for most of us until it becomes tangible. These gods satisfy to some extent man's search for meaning. Science fought, and was persecuted, for attempting to destroy a myth. Universal belief in its powers has created another. Our ancestors made gods of

the elements because they appeared the self-evident cause of their troubles. The fact that their propitiatory rites and ceremonies have subsequently been shown false cannot disprove the fact that many of their troubles did, in fact, arise from the vicissitudes of the elements and that the nature of the myth was largely determined by the nature of their particular environment. Mr. Taylor, by reducing centralisation and mass production to the level of a myth, thereby seems to believe that he has eliminated their very tangible effects upon men. Thus he would throw out the baby with the bath water.

For this reason the nature of our environment is supremely important. Success breeds success. Mass production and specialised production under central authority has impressed people to such an extent that they now believe it can cure all their ills. Mass production, &c., demands the dehumanising of its operators. People who are treated as irresponsible fodder soon begin to act as though they were, in fact, irresponsible fodder. It is therefore the supreme task of scientists and engineers, if they are not eventually to become just another of history's persecuted minorities, to realise that power, and especially enormous power, carries equal responsibilities. That they will not realise this I have not the slightest doubt. The dissolution of contemporary Society into a state of nihilism and totalitarianism seems imminent. So, too, does another tearing down of idols.

To that extent I agree with Mr. Taylor, but I agree to differ upon the *rôle* of an individual whose beliefs happen to differ from those of the contemporary autocracy. In my opinion, the issue is eternal and the only valid pointer to a man's beliefs lies in his actions. Since the actions of the opponents of autocrats are always unpopular to the Mighty, there would appear to be a great future for martyrs whose only satisfaction can lie in demonstrating perennial truths to their disillusioned fellows.

G. A. FELTON.

London, W.11, August 18th.

[We wish to apologise to Mr. F. L. Watson, whose signature to a letter on the above subject in our last issue was misprinted F. L. Waters.—ED. THE E.]

STAGGERED WORKING HOURS

SIR,—I have just seen your Editorial of August 1st on staggered hours and it prompts me to suggest a scheme whereby some of the major difficulties and inconveniences to which you so rightly draw attention might be avoided. It seems to me that if the grid permits of sufficient inter-regional electrical transfer, a scheme of staggering by regions, while it would not eliminate, would greatly reduce the amount of staggering required within a region. The following scheme is, therefore, suggested as being worthy of some consideration.

Taking 8 a.m. to 5.30 p.m. as the normal industrial day, the suggestion is that Southern England should work from 7 a.m. to 4.30 p.m., the Midlands from 8 a.m. to 5.30 p.m., the North of England from 9 a.m. to 6.30 p.m., and Scotland from 9.30 a.m. to 7.0 p.m. The hours of schools, offices, theatres, cinemas, &c., would be shifted by similar amounts, one hour earlier in the south, one hour later in the north, and 1½ hours later in Scotland. The working and social hours could then still be in step in each region for, probably, the majority of the workers. This would be an immense advantage, and would eliminate many of the difficulties which you cite in your Editorial. The regions would be planned so that each had approximately the same electrical load, and the scheme has one very great merit over the normal staggering arrangement, namely, that the domestic early morning load is spread as well as the industrial load. Minor amendments to the hours suggested might make major improvements so far as the electrical spread is concerned; this is a point on which the electric supply authorities could advise.

Such an arrangement should greatly reduce the amount of staggering required within a region.

D. S. ANDERSON.

Glasgow, C.1, August 12th.

[The scheme suggested by Mr. Anderson has already been studied. It was rejected as impracticable on the grounds that alleviation of the load would not be sufficient, that the benefits conferred would not overbalance the inconvenience caused and, probably more importantly, that it was doubtful whether the grid could carry satisfactorily the large inter-area loads required by the scheme. The grid, it may be noted, is designed only to permit, to a limited extent, an overload in one area to be carried by generating plant in an adjoining area. It is not designed to permit the generation of a more substantial fraction of the load outside the area concerned. When during the war substantial amounts of power were required to be transmitted from Eastern to Western districts considerable modification of the grid lines was found to be necessary.—Ed. THE E.]

Literature

SHORT NOTICES

The Presentation of Engineering Evidence. By Lord Macmillan of Aberfeld, Geoffrey Bell and Charles William Knight. London: The Institution of Civil Engineers, Great George Street, Westminster, S.W.1. Price 3s.—This booklet is a record of four lectures delivered before the Institution of Civil Engineers last year. The first lecture, "The Giving of Evidence before a Parliamentary Committee, in the High Court, and before an Arbitrator," by Lord Macmillan, is characteristic of that witty and distinguished lawyer, judge and politician. It contains much that is of guidance to the engineer who is called upon to give "expert" evidence. The second and third lectures, by Mr. Geoffrey Bell, of the Film Centre, Ltd., are entitled "The Technique of Film Production, with Particular Reference to Science and Engineering" and "The Use of Film as a Vehicle of Information" respectively. They should be of value in drawing attention to this comparatively recent method of recording and publicising engineering and scientific achievements, and in indicating the possibilities of cinematography to the engineer. Mr. Bell has much to say in an interesting manner concerning the effective presentation of technical material through the medium of film. He addresses himself not only to the engineer who makes amateur cinema records of his work, but also to the engineer who intends to collaborate with the professional film producer in the making of such a record. Finally, Mr. C. W. Knight rounds off the series by choosing as his title "The Writing of Technical Papers and Reports," a subject which deserves closer attention, in our opinion, in the training of an engineer. By adopting the elementary principles set out, many an engineer would confer a large measure of relief to the readers of his report, and at the same time enhance his prestige with his chief!

Dictionary of Plastics. Compiled by Paul I. Smith. London: Hutchinson's Scientific and Technical Publications, Ireland Yard, E.C.4. Price 15s. net.—The increasing number of people interested in the manufacture and use of plastics in industry and the large amount of literature now available on the subject makes the introduction of this dictionary particularly welcome. Hitherto it has often entailed a considerable amount of time, and reference to many books, to find information on particular subjects. Although no dictionary of this size could hope to give full details and individual reference to satisfy all requirements, the lexicographer, who is an authority on his subject, is to be congratulated in covering the wide field he has in this little book. The details given are clear and concise, and where desirable references are made to fuller sources of information on particular subjects. This dictionary is a valuable supplement to the published works on plastics and will prove of considerable use to all interested in this important branch of industry.

The Cathode Ray Oscillograph in Industry. By W. Wilson, D.Sc., M.I.E.E. London: Chapman and Hall, Ltd. Price 18s. net.—In preparing the second edition of this useful work the author has increased its scope by the addition of much new material, with strong emphasis on the practical aspects of the cathode ray oscillograph in industry. Among the new topics introduced are the electron switch for multi recording with a single tube, the cathode ray faultfinder, and applications such as steel sorting and the measurement of Young's modulus, noise and vibration. Further details are given of radio-location and the extension of its principles to the detection of flaws in conductors by the aid of supersonic vibrations. The chapter dealing with the electron microscope has been considerably amplified, so as to include the more recent instruments, giving further information about their operation, the preparation and mounting of specimens, metallography and the characteristics of electron micrographs. Typical of the practical outlook of this book is the final chapter on construction operation and maintenance, to which a number of additions have been made, including some notes on photographic technique.

The Steam Turbine and Other Inventions of Sir Charles Parsons, O.M. By R. H. Parsons, M.I. Mech. E. London: Longmans, Green and Co., Ltd., 43, Albert Drive, S.W.19. Price 1s. 6d. net.—This little book is one of the "Science in Britain" series which is being published for the British Council. It contains an outline of the work of a man whose genius as an inventor opened a new era in engineering, and whose creations probably had a greater effect on the industrial world than any since Watt's condensing steam engine. It would be difficult to find any engineer to whom the name of Parsons is not familiar, and it is safe to say that his work reflects to greater or lesser extent upon very many branches of industry. The author of this little book is to be congratulated upon his interesting presentation in a condensed form of so many facts about the great British engineer whose work covered such a wide field of application. As a popular book this is well worth reading, and it will prompt all engineers to re-read the excellent biography of Parsons which was written by Rollo Appleyard in 1933 and the Scientific Papers and Addresses of the Hon. Sir Charles Parsons, published in 1934.

BOOKS RECEIVED

Materials of Industry. Fourth edition. By Samuel F. Morseman. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 14s.

Writing the Technical Report. Second edition. By J. Raleigh Nelson. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 15s.

Manual of Foundry and Pattern Shop Practice. By Otis J. Benedict, jun. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 16s. 6d.

Workshop Engineering Calculations and Technical Science. Vol. I. By J. Stoney. London: English Universities Press, Ltd., St. Paul's House, Warwick Square, E.C.4. Price 10s. 6d.

Practical Bookkeeping and Costing. In three parts. By F. A. Gordon and W. Wade. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price: Parts I and II, 6s. 6d.; Part III, 7s. 6d.

A 12-Ton Diesel Shuttle Dumper

FOR some time past Aveling-Barford, Ltd., of Grantham, has been studying the design of a large-capacity dumper with exceptional cross-country performance, suitable for loading from large excavators working in quarries or on contracts. This duty usually entails short-distance transport over rough ground and, because of restricted space, it may not be possible for the vehicle used to turn round. To meet this requirement the firm has designed a six-wheeled rear-tipping dumper with a capacity of 9 cubic yards, or 12 tons, carried at the maximum practical speed in either direction over hard quarry floors or unmade grounds. The tipping gear is mechanically operated but hydraulically controlled, and—an important point—the main gearbox is also hydraulically operated. Two prototypes have been built and are now engaged on acceptance trials. It is hoped to begin production of this first new British vehicle of its type as soon as materials, labour and factory space can be made available.

FORWARD DRIVING POSITION

Both the prototypes have been purchased by Associated Portland Cement Manufacturers, Ltd. The first machine has been at work in a quarry in Ulster for nearly a year with, it is understood, very satisfactory results. The second vehicle is in use in one of the A.P.C.M. quarries at Kirton Lindsey, Lincs., where, recently, we were afforded the opportunity of seeing it in action.

Quarry and Contract Dumping Requirements

In designing the vehicle, Aveling-Barford, Ltd., decided that no compromise was to be permitted in making it suitable for its work. In this connection it is of interest to compare the use of the conventional lightly-built tipping lorry with a large dumper of this type. There are many tipping lorries capable of carrying moderate loads on proper roads, but on the other hand such vehicles, designed for efficient high-speed operation on public highways in one direction, are not very efficient on rough going, especially when a proportion of the travel must be done in reverse gear. As already mentioned, in a quarry a vehicle may be unable to turn round, except at considerable expense in time and tyre wear, and a shuttle service may be necessary. A lorry is efficient in forward travel in top gear at a good speed; its lightness of build is no longer an advantage when working in its lower gears on uneven ground and when heavy loads are dropped into it from an excavator bucket.

With regard to the gear-changing system, a conventional lorry gearbox may be quite satisfactory on good roads where low rolling resistance and moderate gradients permit the momentum of the vehicle to carry it on during the change to a higher gear ratio, but it may be very difficult to handle on soft ground, where the vehicle slows to a standstill as soon as the clutch is disengaged. For this reason the driver uses and remains in an unnecessarily low gear; at other times, when going downhill, he also uses a lower gear than necessary for fear of "missing" his gear change. With a vehicle heavily loaded these points assume considerable importance and justify the adoption of special means for making safe and easy gear changes.

It is therefore clear that there is a field for the economical use of a dumper of the type described below, which is designed expressly for the purpose of heavy earthmoving and quarry work.

General Design of Dumper

The appearance of the new dumper is indicated in the accompanying engravings. It is a rear-tipping machine, carried on a pivoted front axle and on a four-wheeled bogie at the rear, formed by rocker beams on trunnions. The four rear wheels are driven, and are equipped with 14·00 by 24 tyres, whilst the front wheels have 13·00 by 24 tyres. The leading particulars and weights are given in the table below.

Leading Particulars and Weights

Engine:	
Number of cylinders	6
Bore and stroke	120mm × 180mm
Maximum power	128 b.h.p. at 1500 r.p.m.
Speeds:	
Forward	3½, 6, 10 and 17 m.p.h.
Reverse	2¾, 4¾, 8 and 13¾ m.p.h.
Overall length	24ft 3in
Overall width (standard body)	7ft 6in
Overall height	8ft 8in
Main wheelbase	15ft 0in
Wheel track, rear	6ft 4in
Wheel track, front	6ft 1½in
Turning radius	26ft 0in
Weights:	
Empty, approx.	13 tons
Laden	25 tons
On driving wheels, laden ...	20 tons
On steering wheels, laden ...	5 tons

The vehicle is propelled by a six-cylinder Dorman diesel engine, of which the maximum output is 128 b.h.p., giving sufficient power, it is claimed, for ploughing through axle-deep mud or for climbing any gradient on which the wheels will grip. At maximum and idling speeds the engine is governor-controlled. The main accessories to this ruggedly built engine are two filters for the lubrication system, one on the suction and one on the delivery side of the oil pump, thermostatic control of circulating water temperature; oil bath air cleaners and C.A.V.-Bosch injection equipment. Electric 24V starting equipment is provided, but an automatic spragging gear can be used for an emergency hand start.

Driving Position

Undoubtedly one of the more interesting points of the vehicle is its capacity for running in either direction at a fast speed, the gearbox being so designed that all four speeds are available in reverse as well as forward. A reversible driver's seat gives the driver equal facility for steering and control in either direction, and he may reverse the position of his seat without leaving it. The mechanism is similar to that used in the Aveling-Barford 4½ cubic yard dumper. By releasing a catch, the whole seat may be revolved through 180 deg., about the vertical steering pillar. The three control pedals move with the seat, and engage in either position with their respective control rods, for operating the brake, clutch and accelerator. A double-steering wheel is provided, whilst the remaining controls, such as gear lever, tipping lever and handbrake, are equally accessible from either driving position. We noted the facility with which this change could be made, and without previous experience of the vehicle we found it quite easy to handle. The dumper can therefore be driven confidently to the edge of a tip or crusher chute, without loss of time.

Transmission

Power is transmitted from the engine to a main clutch through a short cardan shaft and metallic flexible couplings. This clutch is of the multi-plate lubricated pattern and is hydraulically loaded, with control by the usual clutch pedal.

As we have already indicated, the change speed mechanism is hydraulically operated. Within the gearbox (see drawings on page 178) there are four pairs of constant mesh helical gears, each pair being provided with its own cone friction clutch. These pairs of gears are arranged in two stages of two clutches each, coupled in series, so that either clutch of stage 1 may drive in series with either clutch of stage 2. Consequently, two clutches must be engaged simultaneously; and, as the two inner members of each stage are coupled, and move together, there is no possibility of opposing clutches becoming engaged at the same time or failing to release. These cone clutches resemble those used with synchromesh gears but, unlike the latter, are engaged with enough pressure to permit them to transmit the full torque without the help of positive toothed clutches.

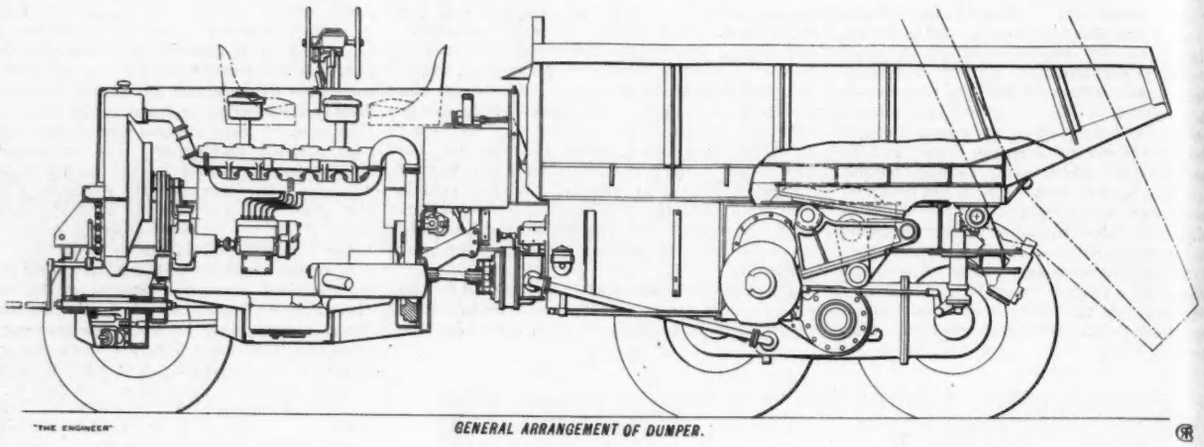
The engaging force for the cone clutches is, of course, considerable. It is provided by hydraulic pressure acting on pistons within the clutches, so arranged that all end thrusts are self-contained and are not transmitted to the bearings. Oil under pressure is led to the pistons through passages in the shafts, with suitable glands, and a master selector valve or "gear lever" controlled by the driver determines which of the clutches shall operate to drive through one or other of the four gear ratios.

As the whole of the change-speed mechanism is under the master control of the main clutch, the cone-selective clutches may be unusually heavily loaded without wear taking place. These cone clutches have only to absorb the energy produced by change of velocity in the freely spinning parts of the gear system, and as the engaging surfaces are lubricated the action is very smooth. Automatic provision is made by hydraulic means to prevent any change being made except when the clutch pedal is depressed. The mating members of the cone clutches are of steel and manganese bronze, and the helical constant-mesh gears are of heat-treated steel.

Reversing and Differential Gears

The output shaft from the constant-mesh trains drives a series of spur gears, which provide for reversing and drive the tipping mechanism. Reversing is carried out by hand-selected dog clutches and the gears give higher speeds forward than in reverse, it being generally

ARRANGEMENT OF SHUTTLE DUMPER



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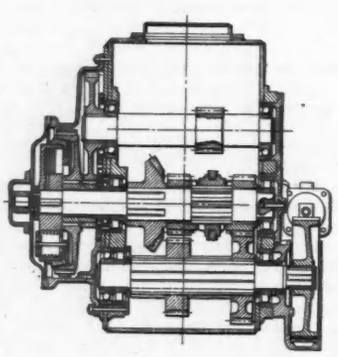
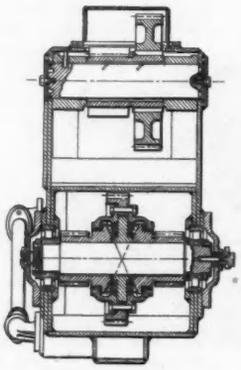
GENERAL ARRANGEMENT OF DUMPER.

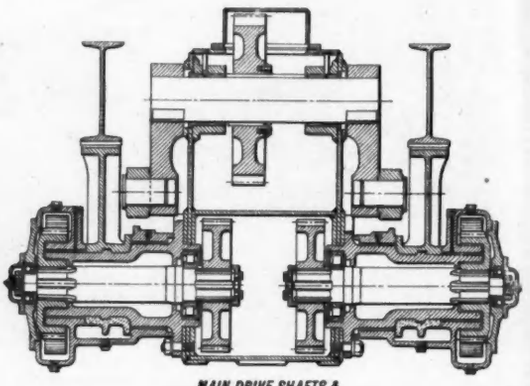


BRAKE SHAFT, BEVEL WHEEL SHAFT & OVERDRIVE SHAFT.

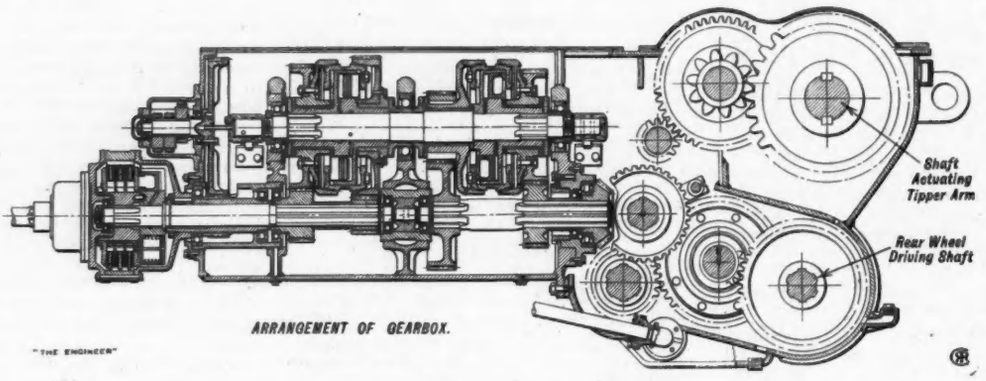
"THE ENGINEER"



DIFFERENTIAL SHAFT & HOIST IDLER SHAFT.



MAIN DRIVE SHAFTS & HOIST ARM SHAFT.



ARRANGEMENT OF GEARBOX.

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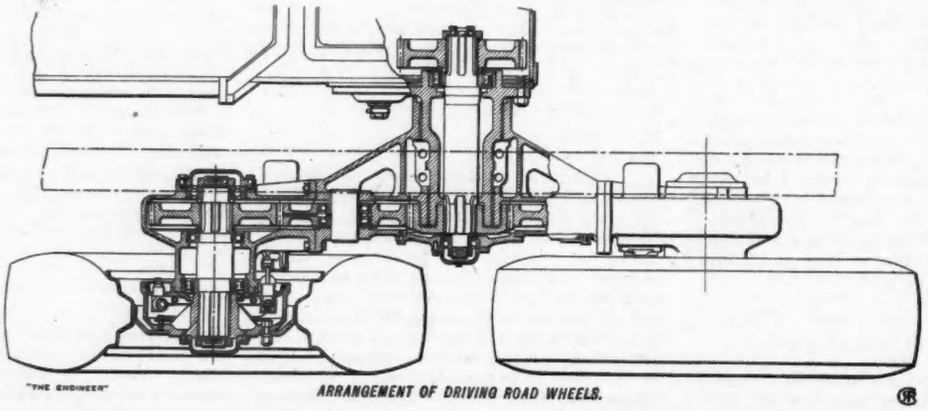

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ARRANGEMENT OF DRIVING ROAD WHEELS.

convenient to travel faster forward than backward, as the driver's view is slightly better when facing forward.

A differential gear is carried on the shaft immediately preceding the main trunnion driving shafts. All transmission gears beyond the helical change-speed gears are of case-hardened nickel-chrome steel and their shafts run in ball or roller bearings, any sleeve bearings being pressure lubricated.

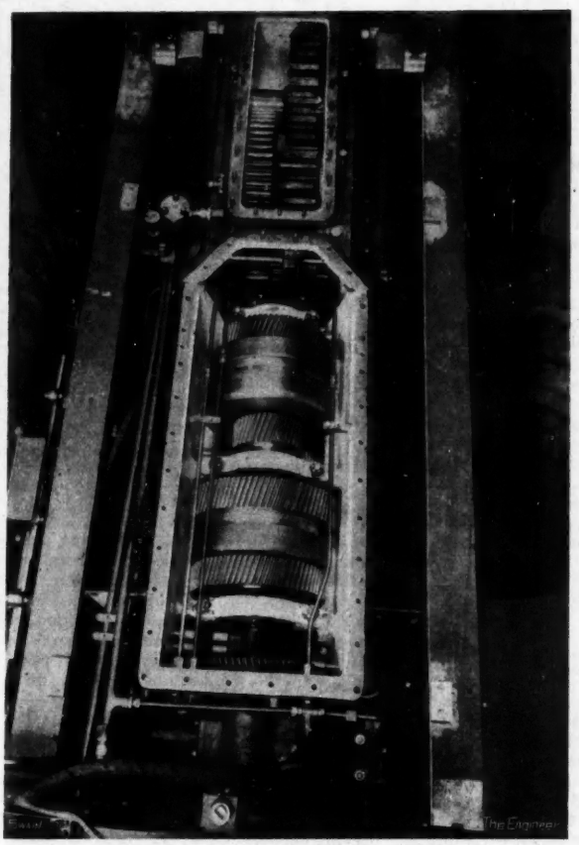
Final Drive

One of the accompanying drawings shows the arrangement of the driving wheels. Each pair of wheels is carried on a rocker beam pivoted about a trunnion projecting from the gearbox and attached by encircling brackets to the main frame side member. The driving shaft passes through the trunnion and at its outer end carries a pinion, which drives through idler pinion gears on the driving axles. The rocker beams and driving wheels are free to move through an angle of 23 deg. each way from the horizontal.

The front axle is centrally pivoted. This arrangement, together with the freedom of movement of the driving wheels, gives a considerable amount of articulation, as is indicated in some of the views we reproduce.

Reverse Driving Position

Dumper at Full Tip



Gearbox with Covers Removed

Brakes

Two independent braking systems are incorporated, a foot brake acting on all four driving wheels and a hand brake acting through the final transmission gears. Both these brakes are applied by spring pressure and are released hydraulically. The foot brakes are of the standard Girling internal expanding pattern, whilst the hand brake, used for parking, is a band brake. Should pressure be lost in the hydraulic system, the brakes can be applied, but cannot be released until pressure is restored. If hydraulic pressure is lost owing to engine or pump failure, and it becomes necessary to tow the vehicle, pressure may be restored to the brake pipe lines by an auxiliary foot pump operable by the driver while steering.

Should a burst occur in either brake pipe between the control valves and the brake cylinders, the spring or springs of the brake affected can be held "off" by screws provided.

Control valves for the brakes are so arranged that hydraulic pressure is reduced in proportion to the effort exerted by the driver, so that the engaging force due to the springs may be applied gradually.

Hydraulic System

Lubricating oil is used as the hydraulic fluid, at a working pressure of 250 lb per square inch, maintained by two cylinders of a three-cylinder pump driven from the engine at about 400 r.p.m. This pump is carried on the gearbox and operates all the time the engine is running. The third cylinder of the pump is independent of the pressure system and serves to maintain oil level in the engine sump, particularly when the vehicle is on steep gradients.

Oil is delivered under pressure from the pump to an air vessel which serves to eliminate pulsations and acts as a reservoir to maintain pressure during variations of service demands. Excess supply is discharged through a relief valve and is used for lubricating certain parts of the transmission, after which it returns to the sump and is filtered before going into circulation again. About three-quarters of the air vessel contains oil and the upper quarter compressed air, and the oil required for energising clutches and brakes is drawn from the bottom of the vessel.

Tipping Action

It is desirable on a large earth and rock-carrying dumper, such as the Aveling-Barford 12-ton machine, to have tipping gear which is rapid and yet can be controlled in all positions, so that earth may be layered or spread and rock may be fed directly to crushers. To meet these requirements the body is tipped mechanically by rollers mounted on two arms, which are connected to a shaft in the gearbox. The shaft is rotated by a train of spur gears (see drawings) under the control of a clutch which in turn is controlled hydraulically.

The tip can be held in any required position and is designed to operate to the full tipping angle of 70 deg. in ten seconds. Power is automatically cut off when the maximum angle is reached, whilst over-tipping is prevented by hydraulic buffers which offer a cushioned and progressively increasing resistance up to a maximum of 16 tons, at which point they become solid. The return of the body is hydraulically controlled at a safe speed, and a safety catch locks the body in its travelling position.

The Gotthard Railway.—The Gotthard Railway was opened in 1882 as a single line between Immensee and Chiasso, Switzerland, and in the intervening years has been gradually doubled. *The Railway Gazette* records that the doubling of the last remaining important length of single track, between Brunnen and Sisikon, is now being completed. The traffic over the old Gotthard Pass road, widened from the original pathway early last century, amounted to about 80,000 passengers a year, in the ten years 1870–1880. In the first full year's working of the railway (1883) 250,000 passengers were conveyed; in 1908—the last year of company operation—750,000; and in 1944 2,000,000 passengers were carried. The average speed of the post coaches was 5¼ m.p.h. and of the first steam passenger trains 17 m.p.h. This was increased on electrification to 40 m.p.h., and later, with improved and very powerful locomotives, to 50 m.p.h. The journey time from Lucerne to Chiasso, by boat and road, was 28 h. The railway reduced this time to 7 h. 25 min. In 1913 the time was 4 h. 46 min. and in 1946 3 h. 37 min. In 1882 there was a train about every sixty-five minutes, and now there is one about every twenty minutes.

The Air Cycle Heat Pump*

By T. F. THOMAS, M.Sc.Tech., A.M.I. Mech. E.†

The Air Cycle Defined.—The cycle considered here is essentially an open-circuit cycle, using atmospheric air as the working fluid; for simplicity the term "air cycle" is used in preference to "open-circuit cycle" or "constant-pressure cycle." The cycle is amenable to many variations, but the basic cycle for a heat pump is indicated at (*a*) in Fig. 1. The separate operations with the corresponding quantities of heat and work per pound of air circulated are :—

(1) Atmospheric air is heated in a heat exchanger to the required temperature. The heat input being the "gross heat to the fresh air" H_g.

(2) The warmed air cooling down to room temperature in the heated space delivers up heat equal to the "net heat" demand H_n. This is the heat pump "load."

(3) The extracted air is compressed to give at least the hot air temperature at (1). Work input is W_C.

(4) Compressed hot air is cooled in the heat exchanger to provide the heat H_g for (1).

(5) The compressed cooled air is expanded in an engine or turbine to atmospheric pressure

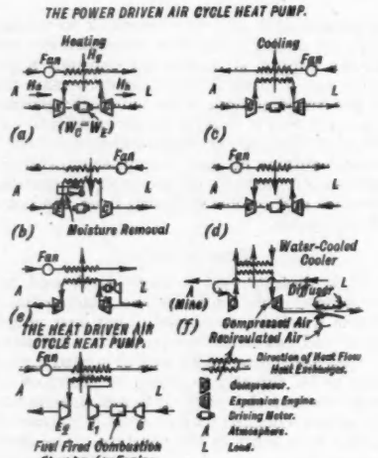


FIG. 1—*The Air Cycle Heat Pump*

and less than atmospheric temperature, giving W_E units of work in the process.

(6) The cycle may be considered as completed by the heat gain from the atmosphere corresponding to the difference between the heat discharged to the atmosphere and the heat intake by the fresh air circulated.

The cycle may be opened to the atmosphere at any convenient point where the pressure is atmospheric and modifications in this direction may be desirable for particular applications. For example, in Fig. 1 (*b*) the high-pressure side of the cycle is at atmospheric pressure so as to provide for both heating and dehumidifying air, as would be required for process drying. In this circuit the compression and expansion machines work at pressures below atmospheric; the first machine expanding the air to a temperature below the dewpoint when some of the moisture might be removed, the following compressor bringing the dehumidified air back to atmospheric pressure at the required higher temperature. In Fig. 1 (*c*) the circuit is open to the atmosphere at the point where the heating load is connected in Fig. 1 (*a*), in order to provide a cold air stream capable of taking up heat as its load. The arrangement in Fig. 1 (*d*) also provides for a cooling load, but in this case the air is passed first through the heat exchanger, while the machines deal with the air after having passed through the cooled space and work at pressures below atmospheric. This appears to be the better plan for summer cooling of ventilating air.

In all cases the difference between the heat input and the heat output must be supplied by some motive power, or

$$(H_n - H_a) = A(W_C - W_E) = \eta_0 H_f \quad . \quad (1)$$

where A is the reciprocal of the mechanical equivalent of heat and H_f is the calorific value of the fuel consumed producing the power required at an overall thermal efficiency η_0, so that the net heat output $H_n = \eta_0 \cdot H_f + H_a$. For electric power available to the consumer as s.h.p. $\eta_0 = 1/6$; thus H_a, the heat pick-up from the atmosphere, needs to be about five times the power consumption if the net heat output is to equal the heat equivalent of the fuel consumption at the electricity generating station.

The driving motor may be coupled to the same shaft as the machines (engine and compressor), or the compressor may be proportioned to handle a smaller quantity of air than the engine—so as to be capable of being driven by the latter—and the balance of the air compressed by an auxiliary compressor taking the full motive power required as in Fig. 1 (*e*). But it is also possible to supply the driving force as pressure or heat energy. In the Hancock system for cooling deep mines, compressed air at mine temperature is used both as motive power and air supply, the heat being carried away by water (supplied also at mine temperature), as indicated in Fig. 1 (*f*).

It is also theoretically possible to have an air cycle heat pump sustained in operation by itself, when moisture saturated air is the working fluid and the condensed moisture is removed after expansion, and thus a smaller total quantity of working fluid is supplied to the compression stage, in which case $(W_C - W_E)$ is negative, the heat pump in effect incorporating an atmospheric steam engine. More practically, high-temperature heat from a fuel-fired combustion chamber may form the source of power as at 1 (*g*), where the heat engine works on the conventional "gas turbine" cycle. In this case

$$(H_n - H_a) = H_f \quad . \quad . \quad . \quad . \quad (2)$$

equalling the net heat supplied in the combustion chamber, so that the net heat output $H_n = H_f + H_a$ quite irrespective of the thermodynamic efficiency of the heat engine cycle producing the motive power.

The Performance Ratio.—To assess the value of the various possibilities of the air cycle heat pump it is necessary to define three ratios for measuring the performance of the cycle when used for heating, ventilating and air drying respectively.

The criterion of performance of a heat pump supplying the net heat quantity H_n is sometimes referred to as the "coefficient of performance," but as this is the accepted term for the ratio of abstracted heat to power consumption appropriate to a cooling machine, as well as numerically different from the ratio of delivered heat to power consumed, it is proposed to call the latter ratio the performance ratio (R_p), which equals

$$H_n / A(W_C - W_E) \quad . \quad . \quad . \quad . \quad (3)$$

Therefore

$$R_p = 1 + H_a / A(W_C - W_E) = 1 + (\text{Coefficient of performance}).$$

The ratio R_p corresponds to the "test bed efficiency" (T) in the Egerton Report on the Heating and Ventilation of Dwellings (page 52), for which electric fires show a value of unity; therefore the value of the (Egerton) coal economy efficiency for the motor-driven heat pump will be $C = R_p \times P \times Q(1 - R) \times \eta_m$, using Egerton Report symbols, in which P represents production and distribution efficiency for electricity (about 0·18), Q represents internal transmission efficiency of warm air heating system (say, 0·95 to cover leakage and infiltration), R represents loss of efficiency due to the change from test to site conditions (say, nil in the absence of experience to the contrary), and η_m represents the efficiency of the driving motor (say, 0·93). Substituting these values, we have $C = 0·16R_p$, compared with $C = 0·18$ for direct electric heating.

Fresh Air Heating Ratio.—The air cycle heat pump does more than provide heat; it also provides a continual stream of fresh air. This is a service of ventilation, the value of which it is necessary to assess for the purpose of comparison with other means of combined heating and ventilation. For this purpose it is proposed to use a fresh air heating ratio (R_f), defined as rate of heating the fresh air supply/heat rate equivalent of the power consumed.

Therefore

$$R_f = H_g / A(W_C - W_E) = R_p \cdot H_g / H_n \quad . \quad . \quad (4)$$

The heat to the fresh air may be less than, equal to or greater than the net heat supplied, according to the nature of the source of heat and the amount of fresh air required to be circulated, but obviously if the desire is for a large supply of fresh air relative to the net heat demand, then considerably more heat may be required to heat the incoming air than is dissipated in the process which absorbs the net heating load.

Corresponding to the fresh air heating ratio there will be a fresh air cooling ratio (R_{fc}) defined as rate of cooling the fresh air supply/heat rate equivalent of the power consumed.

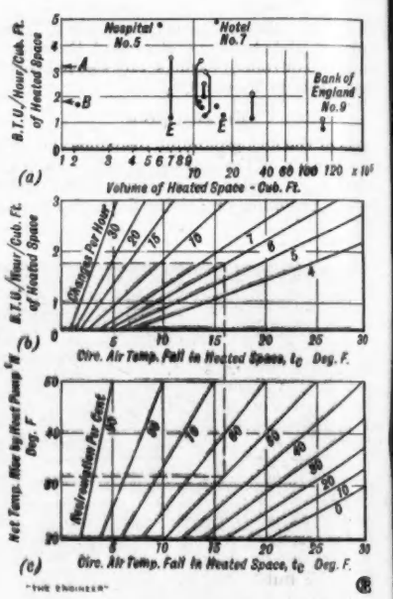

Hospital No.5
Hotel No.7
Bank of England No.9
B.T.U./Hour/Cub. Ft. of Heated Space
Volume of Heated Space - Cub. Ft.
Changes Per Hour
Circ. Air Temp. Fall in Heated Space, t_C Deg. F.
Rise by Heat Pump °F
Recirculation Per Cent
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FIG. 2—*Temperature Ranges for Heating and Ventilation by Air Heat Pump*

● Space heating only.
○ Space heat and ventilation.
A Heating research residence.
B Heating research residence with storm windows.
E All-electric heating.

In any ventilation system, heating or cooling, the gross heat supplied to the fresh air circulated is the appropriate criterion for comparison of performance unless a heat exchanger in the exhausted air circuit is provided, but this would hardly be an economical proposition for an ordinary ventilation system, where at most only some 25 per cent of the heat loss to the atmosphere could be recovered.

The Air Drying Ratio.—If the air cycle heat pump can be used to supply warm dry air for a drying process then we must assess the performance of the machine on the basis of its drying capacity. It is proposed to measure this by means of an air drying ratio (R_D) defined as drying capacity of air delivered by heat pump/heat equivalent of power consumed.

The drying capacity of air may be defined as the heat drop of the dry air in the drying process, i.e., on the assumption of adiabatic evaporative heat exchange, which, for practical purposes, is equal to heat exchange at constant total heat of the air-water vapour mixture.

* Institution of Mechanical Engineers, March 28th. Abstract.

† Condenser Engineering Department, Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester.

Thus, if t_i and t_f represent initial and final temperatures of the air supply in the drying process,

$$R_D = 0{\cdot}24(t_i - t_f)/A(W_G - W_E) \quad . \quad . \quad (5)$$

This definition leaves open the question of the relative humidities corresponding to t_f and t_i, which depend on the particular application.

Application to Space Heating.—For the purpose of space heating the air cycle heat pump will be required to supply heat losses on three main accounts :—

(1) The net heat loss from the heated space through walls, windows, &c.

(2) Heat removed by ventilating air.

(3) Heat required to effect humidification of cold supply air.

In addition to these quantities of heat there are various losses, such as infiltration, which can be taken into account by increasing the effective duty under items (1) and (2).

The problem as it affects items (1) and (2) is

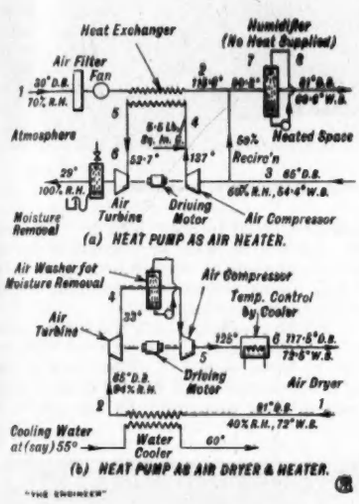


FIG. 3—*Examples of Heat Pump Installations*

illustrated by the diagram in Fig. 2. Here, the heat demand is represented in units of B.Th.U. per hour per cubic foot of heated space, as this corresponds to the units of heat flow in terms of heat drop in a stream of air supplying so many changes of air per hour to the heated space ; it also corresponds roughly to the actual heat demand for space heating for a fairly wide variety of buildings, as is shown at Fig. 2 (a), where the designed space heating consumption of twelve representative modern buildings, including office blocks, public buildings, clubs, hospitals and hotels, is indicated (by dots) with additional values (plotted as circles) for the total of space heating plus ventilation for the seven cases where heat for ventilation is also required. Maximum values are provided by cases 5 and 7, which refer to a hospital and hotel respectively, while the minimum demand is provided by the case 9 of the well-insulated Bank of England. For comparison with a first-class domestic heating service the points A and B have been added representing the heat demand (based on fuel consumption) of the 17,800 cubic feet of heated space in the Warm Air Heating Research Residence at Urbana, Illinois, U.S.A.

The value B is from repeat tests after the installation of special heat insulation, double-sash windows and one storm door. Both A and B are for 30 deg. temperature difference.

It thus appears that a range of demand of 1·0 to 5·0 B.Th.U. per cubic foot per hour must be met and in parts (*b*) and (*c*) of Fig. 2 are shown the corresponding air flow rate (changes per hour) and the circulated air temperature fall (t_c), together with the net temperature rise (t_n) in the air passed by the heat pump which are required to cover this range. Thus, for example, approximately 1½ B.Th.U. per hour per cubic foot of heated space are supplied by six changes per hour with a temperature fall of 16 deg. Fah. in the circulated air, while the net temperature rise produced by the heat pump would need to be 32 deg. Fah. with 50 per cent of circulated air recirculated. If we assume room conditions to be maintained as 65 deg. Fah. (dry bulb) with 50 per cent relative humidity and atmospheric air at 30 deg. Fah. (dry bulb) and 70 per cent relative humidity, then it will be necessary to provide for humidification of the supply air.

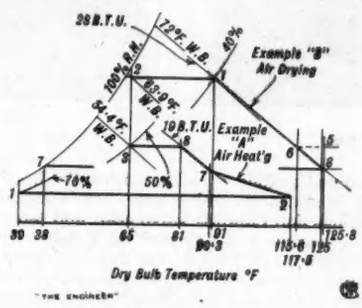


FIG. 4—*Psychrometric Chart Showing State Points for Examples* a *and* b *in Fig.* 3
Total pressure 14·5 lb per square inch

This will require additional heat equivalent to an additional temperature rise in the supply air of 2×9·3 deg. Fah. equalling 18·6 deg. Fah. and giving a total net temperature rise of 50·6 deg. Fah., neglecting any other losses. These data are summarised in Table I, where the state points are referred to by the same numbers as on the diagram Fig. 3 (*a*).

The heat pump cycle can be drawn on an air chart with the following assumptions :—

Efficiency of expansion and compression ...	0·8
Thermal ratio of heat exchanger	0·8
Pressure drop in flow t_1 to t_2, pounds per square inch	0·35
Pressure drop in flow t_4 to t_5, pounds per square inch	0·5
Atmospheric pressure, pounds per square inch	14·5

There is some doubt about the expansion of the moist air to atmospheric pressure. Dry air would fall to a temperature of some 18 deg. Fah., but if throughout the expansion the air vapour mixture remained in thermal equilibrium the exhaust temperature would be no less than 29 deg. Fah., *i.e.*, only 1 deg. Fah. below the assumed inlet temperature. However, saturated air at this temperature would probably create a considerable fog. With the use of an air chart the figures in Table II were obtained.

These ratios do not take account of the power absorbed by the initial passage of air through the heat exchanger, since it is assumed that the air is at atmospheric pressure at the compressor inlet. Adding the heat equivalent of the work of pumping the air at 80 per cent efficiency

TABLE II

Compression work, B.Th.U. per lb (dry air) ...	17·25
Expansion work, ditto	8·94
Net work by difference, ditto	8·31
Net heat available, ditto	12·1
Heat to fresh air, ditto	20·54
R_p	1·45
R_f	2·47

through 0·35 lb per square inch pressure we get 8·70 as the total work in B.Th.U. per pound of air, giving a value of $R_p = 1{\cdot}39$ and $R_f = 2{\cdot}36$.

(To be continued)

TABLE I.—*State Points*

State point	Description.	Dry bulb temperature, deg. Fah.	Wet bulb temperature, deg. Fah.	Relative humidity, per cent.	Total heat, B.Th.U. per lb.	Weight of moisture.	
						Grains per lb.	Lb per lb.
1	Atmosphere	30	—	70	—	17·2	—
2	Air delivered by heat pump	115·6	66·4	—	—	17·2	—
7	After mixture with recirculated air ...	90·3	60·7	15	19	31·7	—
8	Conditioned air	81	60·6	29	19	46·2	0·0066
3	Extracted air	65	54·4	50	—	46·2	—
4	Compressor outlet	137	—	—	—	—	—
5	Turbine inlet	52·7	52·7	100	—	—	0·0063
6	Discharge to atmosphere	29	29	100	—	—	0·0034

Marine Barking Unit, Canada

BOWATER'S Newfoundland Pulp and Paper Mills, Ltd., of Corner Brook, Newfoundland, has placed its second marine pulpwood barking plant in service. This second unit consists of a 12ft diameter by 45ft barking drum mounted on a welded steel barge, 9ft deep by 30ft wide by 100ft long and equipped with a jack ladder, discharge conveyor, return conveyor, bark sluice and diesel engine. This barker will operate on the East Coast of Newfoundland and will serve two large pulpwood centres, Tommy's Arm and Hall's Bay, both of which lie in Notre Dame Bay. The pulpwood processed by barker No. 2 comes from large timber limits on Notre Dame and Bonavista bays and consists solely of spruce and fir. The reason for having mobile marine barker units is so that they can be moved in and out of small bays. They are not used on inland waterways or lakes, but only on salt water.

Pulpwood is driven down the main rivers from the timber limits and, upon its arrival at the mouth of the bay, is impounded by means of heavy wooden holding booms. A chain of these booms extends across the entire width of the bay and the marine barking unit is anchored adjacent to it. The impounded logs are fed to a jack ladder, which conveys them into the charging end of the barking drum. The bark is removed from the wood by the constant rotation of the drum, which causes the logs to rub against each other and also against the bars that form the shell of the drum. Water is sprayed on the wood to wash the bark into a pit underneath the drum. Water is also used to flush the bark into a sump for disposal. After travelling through the drum the barked logs are discharged on to a flat rubber belt conveyor which operates on rollers. This conveyor is approximately 3ft wide and has steel plate sides to keep the wood from falling off. It delivers the barked logs to a second holding boom, which is connected to the marine barking unit. They are held in this boom until a steamer arrives to take them aboard. Any logs that are not completely barked are diverted from the main conveyor by an attendant to a small conveyor which returns them to the charging end of the barking drum.

Bowater's marine barkers are capable of producing 400 cords of clean wood per twenty-hour day. The drums, suspension type U-bar units, designed by Fibre Making Processes, Inc., were supplied together with carrying chains, guide rolls, &c., by the Horton Steel Works, Ltd., of Fort Erie, Ontario. Fletcher, Sons and Co., of Montreal, were naval architects and designers of both units. Barker No. 2 is equipped with a 320 h.p. diesel engine, which not only drives the drum and conveyors, but also furnishes electric power for lighting and operates a pump to supply water for washing down the bark and flushing it from the pit.

NON-FERROUS METALS CONSUMPTION.—Figures of consumption of non-ferrous metals in the United Kingdom during the second quarter of 1947 covering zinc, lead, tin, cadmium and antimony, have now been issued by the Directorate of Non-Ferrous Metals. Consumption of virgin metal only in the period was as follows :—Zinc, 57,946 tons ; lead, 40,237 tons ; tin, 6857 tons ; cadmium, 130 tons ; and antimony, 1317 tons.

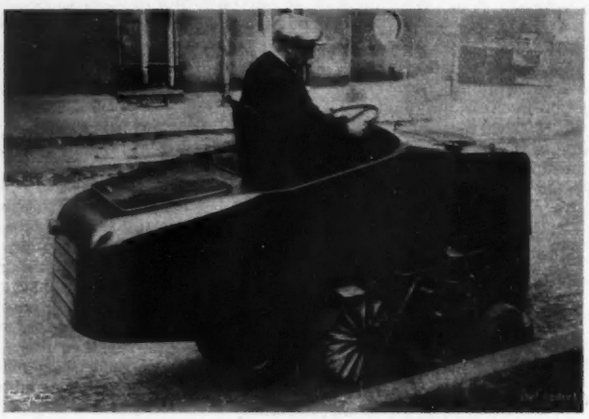
Mechanical Road Sweepers

SHORTAGE of manpower is encouraging the Paris municipal authority to carry out tests with a mechanical road sweeper and a pavement sweeper, intended to economise both in time and labour.

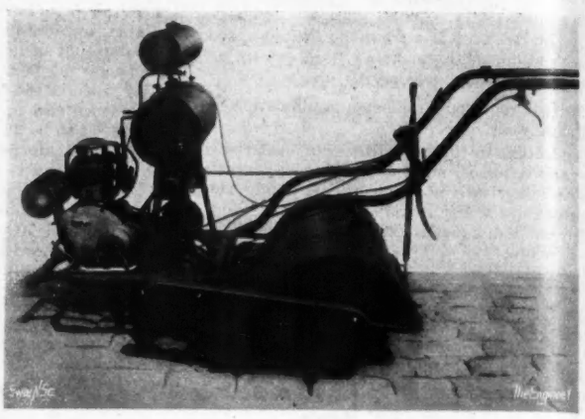
The road sweeping machine, illustrated herewith, runs on petrol. It is propelled by a side-valve four-cylinder engine with bore and stroke of 63mm by 95mm, giving 11 h.p. at 1200 r.p.m. Cooling is by thermo-siphon action and there is a four-speed gearbox. Revolving brushes are fixed to the front of the vehicle and are put into action by a lever placed near the gearbox, which permits the rotational speed to be controlled independently of the speed of the vehicle. A clutch controls the brushes when the vehicle is stopped and separate control is arranged for the main brush as well as for side brushes placed to the right and left. The side brushes clean gutters and direct sweepings into the path of the main brush. The latter is so mounted that it can move away if it meets a solid obstacle, and it can be lifted or lowered by the driver.

The main brush cleans areas not reached by the side brooms and deposits sweepings into a receptacle. A uniform brush pressure on the ground is assured by a counter-balancing system. The receptacle is emptied by a handle worked by the driver from his seat. Water is sprayed in front of the sweeper from a water tank containing 300 litres, carried on the vehicle, placed above the receptacle. Bendix brakes are fitted to the four wheels. The machine is produced by Laffly, 77, Avenue Niel, Paris, 17e.

The second sweeper, also illustrated, has been specially produced for cleaning pavements, railway platforms, factories, &c. It is driven by a single-cylinder engine giving 1 h.p. at 2000 r.p.m. This engine drives a cylindrical brush 750mm long and 420mm in diameter. Sweepings are projected into a box, which is emptied simply by tipping. Seventeen litres of water are carried by the machine to lay dust before sweeping. The vehicle moves at walking speed, weighs about 70 kg, and is mounted on two rubber-tyred wheels spaced closely together, thus permitting the machine to be turned in a confined space.



MECHANICAL ROAD SWEEPER IN USE



MECHANICAL PAVEMENT SWEEPER

Experiments with Roller Bearings on L.M.S. Locomotives

TWENTY-TWO of the 150 new steam locomotives which are being built in the workshops of the London, Midland and Scottish Railway Company are being experimentally fitted with roller bearings. Whilst reduced coal consumption will possibly result from the fitting of these bearings, further experiments for fuel economy are to be made with twenty locomotives fitted with the Caprotti type of poppet valve gear. Ten of these locomotives will be fitted with roller bearings, and the remainder with standard plain bearings.

Two 4–6–2 class "7P" passenger locomotives being built at Crewe will be a development of the existing "Duchess" class and will incorporate roller bearings to all the axles of both locomotive and tender. The bearings will be supplied by British Timken, Ltd., and the Skefko Ball Bearing Company, Ltd.

Of seventy class "5," 4–6–0 locomotives being built, thirty will be redesigned and equipped as follows:—Ten with roller bearings and Walschaerts valve gear, ten with roller bearings and Caprotti valve gear, and ten with plain bearings and Caprotti valve gear. These three groups of locomotives will be tested one against another, and also in comparison with a batch of ten standard Class "5" locomotives having plain bearings and Walschaerts valve gear. The trials of these forty locomotives will include not only the usual dynamometer car tests but also a detailed comparison of costs.

The Caprotti valve gear will be supplied by the Associated Locomotive Equipment Company, Ltd., and the roller bearings which will be applied to all axles of both locomotive and tender will be supplied by British Timken, Ltd.

AMERICAN RAILWAY EQUIPMENT.—According to statistics published by the Association of American Railroads, the Class I railways of the U.S.A. had 109,556 new freight wagons on order on July 1st, and in the first six months of this year they put 20,735 new wagons into service. There were also 794 locomotives on order on July 1st.

River Mud Clearance by Jet Engine

SOME experiments were begun early this week in clearing mud from the bed of the River Thames by the employment of a jet aircraft engine mounted on a barge. The first experiment took place near a disused wharf at Erith, and the jet engine, which was similar to those first fitted to the "Meteor" fighter aircraft, blew 40 lb of air per second at the river bed. As the engine was opened up water was thrown up as though a continuous series of depth charges was being made.

It will be recalled that in the severe weather at the beginning of this year a jet engine was used for the dispersal of extensive snowdrifts, and it is this idea which has led to these experiments in river dredging. By the use of very high pressures it is hoped that it will be possible to disintegrate the mud in such a manner that it will be washed away by the tide. The object appears to be to blast at the mud through a decreasing depth of water and ultimately at the bare mud itself. The accompanying engraving shows the first experiment in progress. In further experiments, which, it was hoped to undertake yesterday—Thursday—the intention was to have the barge stranded on a mud bank and to direct the jet against the bare mud.

The experiments are being conducted by Power Jets, Ltd., in co-operation with William Cory and Sons, Ltd.

MUD CLEARANCE BY JET ENGINE

South African Engineering Notes

(By our South African Correspondent)

Manufacture of Copper Tubes

An interesting industrial development has recently taken place in the Union, which will have an important effect in meeting the present serious difficulty in obtaining supplies of essential engineering materials from overseas. By arrangement with Imperial Chemical Industries, Ltd., Stewarts and Lloyds, of South Africa, Ltd., has now commenced the manufacture of copper tubes in South Africa. Coincident with the above arrangement, Stewarts and Lloyds will now act as agents in South Africa for the sale of all non-ferrous tubes manufactured by I.C.I. Metals, Ltd., Witton, England.

South African Railways

According to the recently issued General Manager's report on South African railways for the year ended March 31, 1946, a beginning has been made with the construction of a new direct rail connection between Springs and Welgedacht. Certain preliminary works have been carried out in connection with the provision of a double line between Woltemade No. 1 and Bellville, which project was authorised in 1945. Parliament, during the 1946 session, authorised the construction of two important new lines, one from Whites to Odendaalsrust, the twenty-four mile length of which is estimated to cost £421,059, and the second from Rangeview to Natalspruit, at an estimated cost of £334,649 for 13·6 miles. Two short lines at Vereeniging, to cost £181,071 and £38,222, respectively, were also authorised. Sixty-two steam locomotives and eight electric locomotives were placed in service during the year. These new additions have considerably strengthened the engine-power position, but the establishment still falls far short of requirements, and it is not possible at this stage to withdraw from service the large number of obsolete engines that should have been scrapped some years ago. The placing in traffic of locomotives now in the course of being delivered or under erection in the Administrator's workshops, in addition to replacements expected to arrive from overseas during the next two years, will, however, permit a start to be made with the engine-scrapping programme. The total tractive power available to the Administration at the close of the period under review (exclusive of electric motor coaches) was 77,463,736 lb, as compared with 74,754,016 lb at March 31, 1945. The number of standard gauge passenger vehicles in service at March 31, 1946, totalled 4843 as against 4850 at the end of the previous year, seventeen having been scrapped during 1945–46, and ten added to the establishment. New goods vehicles to the number of 1872 were placed in service, of which 820 were imported from overseas, 539 built in the Administrator's workshops, and the balance of 513 manufactured by a South African firm. Great difficulty has been experienced in maintaining the output of all mechanical workshops at the desired high level. Shortage of technical and other staff, the inability to obtain new machinery and equipment, and inadequate facilities, were the chief impediments to the speedy completion of repair and maintenance work, which was of an extremely intensive nature throughout the twelve months. New mechanical workshops are being provided at Durban, Pretoria, and East London, the aggregate cost of which is estimated at £5,803,000.

Base Minerals Development

In the past the expansion of the Union's base mineral industries has been impeded by a number of factors which have hampered prospectors and prevented the development of promising deposits. These difficulties should be greatly reduced by the Reserved Minerals Development Bill, which the Minister of Mines, Mr. S. F. Waterson, has introduced in the House of Assembly. This Bill provides for the registration by the Registrar of Mining Titles of all prospecting licences issued to surface owners of land. A new provision seeks to make a notarial deed granting the right to prospect for minerals, together with the right to acquire the lease of mineral rights, binding upon the successor-in-title of the owner of the land.

Section 14 of the principal Act provides that whenever the owner, licensee or lessee of land, the mineral rights of which are reserved by the Crown, does not avail himself of the right of prospecting granted under the Act, or does not prospect to the satisfaction of the Minister of Mines, the Governor-General may, subject to certain conditions, authorise any person to enter on the land on behalf of the Government for the purpose of prospecting for or mining or removing any minerals. In terms of amendments proposed in the Bill the Governor-General will have the same powers whenever the nominee of the owner, licensee or lessee, does not prospect for minerals to the satisfaction of the Minister.

Base Minerals Production and Export

Coal and copper are included in the considerable number of South African base minerals which increased in production last year, but in both cases the advances were comparatively slight. At 26,016,307 tons the coal output was 52,022 tons more than in 1945, according to statistics now issued by the Department of Mines. Production of ingot copper increased by 1758 tons to 12,790 tons, with exports, mainly to Italy, declining by 518 tons. Of the blister copper output of 16,667 tons (an increase of 1613 tons) the United States took over 6000 tons.

A notable advance was made in manganese output and exports, both being more than double the 1945 figures. Of the total of 356,166 tons exported, individual amounts ranged from 4256 tons to Holland, to the United States import of 272,026 tons. It is pointed out that the unusual hardness of South African manganese ores makes them particularly suitable for export.

Chrome also stands high in the list, production at 233,970 tons having increased by 124,741 tons. The exports of 269,979 tons went to twelve countries, the United States receiving 216,307 tons.

Output of andalusite, which may be used for manufacturing refractories and certain porcelain ware, such as sparking plugs, high-tension insulators and chemical apparatus, rose from 5·38 tons in 1945 to 6056 tons last year. In general it is stated that the iron tenure is greater than that of the famous Rocky Mountain material.

Another notable increase is seen in the output of vermiculite at 5535 tons against 2765 tons in 1945. Exports totalled 1737 tons, the United States importing 1537 tons. Vermiculite is useful for thermal and acoustic insulation and also for making light plaster and boards. Very large deposits occur in the Palabora area of the north-eastern Transvaal, but although the total quantity is vast, much of it is scattered and only part of it, in present conditions, appears to be commercially remunerative.

Johannesburg's New Station

Plans for Johannesburg's new station layout are well advanced and work will shortly be started on the Wanderers Street Bridge, which is the third to be tackled in the scheme to provide better traffic outlets to the northern suburbs. The work of excavating the Wanderers ground for a portion of the new station layout is up to schedule and preparation is being made for the elimination of steam working in the Reef area. As soon as the necessary excavations have been made on the Wanderers ground the superstructure of the new main line concourse will be begun. In the meantime, plans for the elimination of steam working within the inner Reef area are keeping pace with the development of the new station. The most important of these is the building of the new electric running sheds at Braamfontein. These will provide a workshop with a floor space of nearly 96,000 square feet, a slightly smaller inspection shed, stores and administrative offices. Six sets of track will run through the inspection sheds and four into the workshop, and there will be sufficient overhead space for 40-ton cranes to be operated. Building is already far advanced and when the sheds are erected and the complete change-over to electric working has been made, the steam locomotive depot at Braamfontein will be eliminated. New electric locomotives have arrived in the Union and have already been tested on the Reef system. Braamfontein yard is being remodelled for the more extensive use of electric working, but before the full change-over from steam to electricity can be made all goods sidings on the existing electrified section have to be wired.

Railways

Steel coaches for South African suburban railway services, in place of the wooden coaches at present in general use, are being considered by the Railway Administration. Such coaches will greatly increase safety over busy suburban routes in Cape Town and Johannesburg, and experts are at present investigating whether these coaches will stand the extremes of temperature in the Union. The cost factor is also receiving attention. Should experiments prove satisfactory, it is proposed to call for tenders for the supply of 100 steel coaches, some of which might be manufactured in South Africa. The only steel-coach trains at present used by the railways are the Blue Train running between Johannesburg and Cape Town and the new luxury service between Johannesburg and Durban.

Expansion of Engineering Industry

The extent of the expansion of South Africa's engineering industry under the impetus of war is revealed in "The Years of Crisis," a record of the Union's metal industries during the war, just published by the S.A. Federation of Engineering and Metallurgical Associations (Safema). For the first time the extent of South Africa's munitions output is revealed. This production included 3,691,931 shells and 4,361,384 cartridge cases; 2,568,652 mortar bombs, 4,970,502 grenades and 466,938 land mines, 602,409 aircraft bombs, 62,452 complete rounds of anti-tank ammunition, 11,323 field mortars, 19,605 bayonets, 691 howitzers, nearly 20,000 tons of small arms ammunition, 5770 armoured vehicles and 35,000 motor vehicles, more than 900 Bellman hangars, 39 W. and D. hangars, 79 small box girder bridges and 70 Callender Hamilton bridges, 100 barges, each of 250 tons capacity, and 5 floating docks. The major contracts executed by the structural steel section alone of the engineering industry absorbed about 150,000 tons of steel. Many thousands of 3in mortars were made. Gun sights, mortar sights, and optical instruments were manufactured in large quantities, while the demand for engineering stores, mainly for the Eastern Group armies and for Middle East spares, made enormous calls on the national resources of manpower, material and plant. In addition, thousands of warships and merchant vessels were repaired at Union ports. The Union produced a high percentage of the 0·303 ammunition of the British Empire, and was second only to Britain herself in the manufacture of 1000 lb bombs. Practice bombs were turned out at the rate of 100,000 a month. Notwithstanding the steadily rising level of production, the industry became progressively less dependent on imported supplies. The production of open-hearth steel ingots and rolled and drawn products increased from 743,500 tons in 1939 to 972,500 tons in 1944. Many special steels were successfully developed, while the plate rolling mills at Vanderbijl, established to meet a grave emergency, are now producing an average of 300 tons of rolled steel plates per eight-hour shift. Before the war there were few moulding machines in the Union and only one fully mechanised foundry was in production. To-day there are several mechanised foundries engaged in the large-scale production of castings, either for specialised products, such as stoves, pumps, valves, windmills and water taps, or for the quantity requirements of other manufacturers.

Industrial and Labour Notes

Control of Engagement and Longer Working Hours

The Joint Consultative Committee of the National Joint Advisory Council held a special meeting on Wednesday of last week to consider the details of proposals put forward by the Government for dealing with certain aspects of the economic crisis. The Minister of Labour, Mr. George Isaacs, presided.

One of the matters discussed by the Committee was a General Control of Engagement Order, and, according to an official statement, approval was given to a proposal that the Order should apply to men between eighteen and fifty years of age, and women aged eighteen to forty inclusive. It was agreed, however, that women with children of their own under fifteen living with them should be excluded from the scope of the Order; that ex-Service personnel during the period of their demobilisation leave should be free, as hitherto, to select their own employment; that employment in a professional, administrative, executive or managerial capacity should be excluded; and that dock employment and the Merchant Navy should also be excluded in view of the special joint arrangements governing engagement in those two employments. The Order, it was expected, would become effective on October 1st next. The Committee was informed that it was not proposed to alter the existing Control of Engagement Orders covering the coalmining, agricultural, building and civil engineering industries.

There was also a general discussion on the question of a temporary lengthening of working hours to increase production in dollar-earning and dollar-saving industries, and in basic industries essential to the expansion of other industries. The Committee agreed that, in order to meet a critical situation and as a short-term policy, these industries should increase their hours of work to the extent that was necessary and practicable having regard to available supplies of fuel, power and materials. Furthermore, it was agreed that those industries with adequate supplies of coal and raw materials should be approached on the matter at once, whilst other industries should be asked to increase their hours of work as soon as supplies of coal and raw materials permitted. It would be, the statement remarked, for each industry to work out through the established negotiating machinery, the method by which an increase in hours should be secured.

With regard to the staggering of hours for spreading the electricity load, attention was called at the meeting to the urgency of concluding regional and district plans. It was stated that there would be difficulty in putting staggering schemes into operation by October 1st unless the necessary arrangements for terms and conditions of employment were made in good time. Both sides of the Committee indicated that they had drawn the attention of their affiliated organisations to the engineering industry's agreement as a guide. They now agreed in stressing the urgency of settling those questions, particularly in view of the time needed by transport undertakings to adapt their schedules to changed hours of working. It was pointed out that unless the necessary arrangements were made speedily there would be a danger of load-shedding.

Iron and Steel Production

Figures issued by the British Iron and Steel Federation last week show that production of iron and steel in the United Kingdom declined during July from the rate achieved in June, and was below the rate prevailing in July of last year. The production of pig iron in July averaged 143,500 tons a week, which represents an annual output rate of 7,460,000 tons. Production in the preceding month of June was at an annual rate of 7,501,000 tons. The production of steel ingots and castings in July averaged 211,700 tons a week, which corresponds to an annual rate of 11,007,000 tons. The annual production rate running in June was 13,206,000 tons, and in July of last year 11,759,000 tons.

Commenting on the figures, the Federation says that iron and steel production continued to be limited in July by coal supplies and was affected to an even greater extent than normal by annual holidays, which this year tended to fall more than usual in July. Furthermore, the new arrangement for six days' additional holiday with pay has to some extent increased the length of this year's holiday period.

Total steel production for the first seven months of this year amounted to 7,040,000 tons, and if the Government's target of 12,500,000 tons for 1947 is to be achieved, production in the remaining months of the year will need to be stepped up to an annual rate of 13,500,000 tons. This expansion, it is emphasised, will depend largely on securing an increased output of pig iron. Two additional blast-furnaces came into operation at the beginning of this month and six further furnaces are to be blown in before the end of September. At the same time, it is hoped that when the holiday period is over, the expansion of coke supplies, which has been planned, will be achieved.

The Confederation of Shipbuilding and Engineering Unions

The general executive council of the Confederation of Shipbuilding and Engineering Unions has stated that it will support the Government's plans for dealing with the country's economic crisis. After discussing the situation at a meeting in Newcastle-upon-Tyne last week, the council passed a resolution "pledging full and complete support to the Government's proposals to secure economic stability, progressive improvement in the standard of living, and full employment for our people."

The Sale of Government Factories

Some comments on the sale of Government factories by private treaty are made in the third report from the Committee of Public Accounts which has been published recently by H.M. Stationery Office (price 9d.). The report says that the normal Government policy in disposing of surplus factories is to lease them to approved firms for industrial use, but some of the wartime agreements with firms operating Government factories gave those firms an option to purchase the factories on the termination of the agreements. Where such options are exercised, sales are generally negotiated after valuation by the Inland Revenue Valuation Department, but that Department did not feel able to assess the value of certain light metal and alloy factories erected between 1938 and 1943 in order to expand production during the war. Some of this expansion, the report remarks, is of very little use in peacetime.

The Treasury asked to be consulted regarding the disposal of any of the factories where the Ministry of Supply proposed to sell below four-fifths of estimated 1939 value less depreciation at Inland Revenue rates, and the report says that some have been sold to the operating firms at prices markedly below their depreciated 1939 values. The largest instance brought to the notice of the Committee was of a factory costing £3,100,000 and sold for £750,000, the depreciated 1939 value being £1,767,000. In evidence before the Committee, the Ministry of Supply explained that, owing to the specialised layout of this particular factory, a great part of it would not be of much use to the purchaser, but agreed that he had got a very good bargain. It was definite Government policy, in order to encourage the light metals industry, to dispose of these factories on specially favourable terms to existing firms in the industry, which precluded the factories being offered for public sale even where options were not exercised.

The Committee of Public Accounts observes that it recognises that the wartime agreements must be honoured, but it considers that there should be some time limit within which the option to purchase factories can be exercised on specially favourable terms. In view of the evidence submitted regarding the prosperity of the light metals industry, the Committee recommends that a date should be fixed after which the factories remaining unsold should no longer be available on specially favourable terms to firms in the industry.

Second-hand Steel Tubes

The Iron and Steel Board is concerned about the unauthorised exports of second-hand re-usable tubes, and in particular locomotive seamless boiler tubes. All holders of HH/2 HD licences have, therefore, been notified, by a circular letter dated July, 1947, that the acquisition and disposal of all second-hand steel tubing is governed by the same general principles as new tubes, *i.e.*, such tubes having been acquired on the authority of HH/2 HD licence they can only be disposed of against the quotation of departmental symbol, contract and period number, authorised on form "M," or to persons, who, being themselves holders of an HH/2 HD licence, quote that licence number on their order. The only qualification to this general procedure is the case of a person who takes advantage of the small quantities exemption provisions of the Control of Iron and Steel Order, and furnishes the necessary certificate.

This means that no second-hand tubes may be exported except by sanction of a disposal licence issued by the Iron and Steel Board. The fact that it is unnecessary to obtain a Board of Trade export licence does not relieve the licensee or exporter of the obligation to obtain authority to export from the Iron and Steel Board. Notwithstanding that the Control Orders are binding on all licensees and second-hand dealers, it is stated that unauthorised shipments have, in fact, occurred. The Board takes a serious view of the matter, and licensees are warned that non-observance of the Orders may lead to withdrawal of the HH/2 HD licence and to proceedings.

Coal Output

Statistics issued on Wednesday last by the Ministry of Fuel and Power show that in the month of July the production of deep-mined coal in Great Britain declined to 3,112,300 tons a week, and that the saleable output of opencast coal averaged 219,900 tons a week. The comparable figures for June were 3,623,900 tons of deep-mined and 227,400 tons of opencast coal.

The decrease in the output of deep-mined coal in July is attributed by the Ministry to holidays, which, it is estimated, resulted in a weekly loss of output of nearly 600,000 tons. It seems likely that the output for August may be affected even more by holidays, as weekly output in the first two weeks averaged 2,373,200 tons. On the other hand, the loss of mined coal in July through disputes dropped to 4500 tons a week, compared with 38,300 tons in June.

Voluntary absenteeism at the coal face increased during July, the figure being 6·93 per cent, compared with 5·84 per cent in June. In July, 1946, voluntary absenteeism at the face was 11·01 per cent. At the beginning of July there were 718,300 wage-earners on colliery books, but during the month the net increase in the number of wage-earners amounted to only 800, compared with an increase of 2400 in the preceding month. The shifts worked at the coal face per wage-earner on colliery books in July averaged 3·75 a week.

The total inland consumption of coal during July averaged 2,993,000 tons a week, and overseas shipments and bunkers took up 100,000 tons a week. Distributed stocks in July increased by 1,500,000 tons and in the week ended August 9th they totalled 11,858,400 tons, which was approximately 2,400,000 tons more than at the same time last year.

French Engineering News

(From our French Correspondent)

PARIS, August 15th

Jean Majorelle, Petroleum Co-ordinator for France, has predicted that the country will have to face several more years of petrol rationing. Even if American shipments to France were maintained at their present level, he stated that lack of dollar credits would restrict consumption. Although the United States supplied only 20 per cent of France's petrol, Iraq, Iran and Arabia supplied 37 per cent and Venezuela supplied 20 per cent, but all had to be paid in dollars.

Another factor contributing to the shortage in France is lack of refining equipment. Most oil imports come as crude oil, but France's refining capacity is only about two-thirds that of pre-war, or about 5 million tons a year. Although motorists are deprived of petrol owing to the shortage, there has been much progress in the processing of fuel oil to replace coal in industry, amounting this year to over 2 million tons compared with the previous figure of 1,200,000 tons a year.

* * *

Belgian industry is evidently not very pleased with the clause in the new commercial agreement between France and the Belgo-Luxemburg Economic Union, which stipulates that the Union should supply France with sheet steel. The Brussels paper, *Echo de la Bourse*, points out that France never bought steel from Belgium or Luxemburg before, but was always a competitor for steel products. It states that Lorraine is a big iron ore producer and fails to see why France should be supplied by Belgium and Luxemburg which have to refuse steel to traditional customers such as China and Argentina.

To this the French reply that reconstruction needs in France are so great that national stee' production cannot cover them. And although the iron ore is still available, there is a grave deficiency in coal. Moreover, these necessities are obtained in exchange for French exports to the Economic Union, including phosphates, potassium, soda products, textiles, colonial products, automobiles, mechanical and electrical material, and wines.

* * *

The Renault National Regie has just issued a communiqué about its activity during 1946.

At the time of the requisition, October, 1944, employees fell to 13,000, rising to over 20,000 in January, 1946, and then passing 30,000, which approaches the average pre-war figure. This was accompanied by increased production. The difficulty was, and remains, recruitment of professional personnel. The Regie is attempting to solve this problem by various methods. It is estimated that actual production compared with theoretical production is 1.25 to-day compared with 1.1 before the war. Absenteeism also has dropped as food rations have improved. Daily production in June, 1947, was as follows: —Juvaquatre, 100, of which 95 per cent was exported; light vans, 24 (90 per cent exported); 1-ton vans, 35 (45 per cent exported); 7-ton vans, 10 (30 per cent exported); autocars, 4 (1 per cent exported); agricultural tractors, 12.

Technicians of the Regie are concentrating on standardisation, only constructing one tourist car model compared with twelve pre-war models, and five models of industrial vehicles against twelve pre-war. Modernisation of machinery is also proceeding. Since the end of 1944, the average age of machine tools has dropped from twenty to seventeen years. Future efforts will be concentrated on the large-scale production of the 4 h.p. car, of which fifty prototypes have been produced. Tooling is now in progress for large-scale production of this model. The choice of a single model of agricultural tractor of which two versions are produced, one for agriculture and one for vine growing, has been determined by the desire to produce a quasi-universal tractor for all French needs. Concentration on this model and the resultant standardisation have enabled tractor production to be raised to ten times the pre-war figures.

Notes and Memoranda

Rail and Road

EMPLOYMENT ON AMERICAN RAILWAYS.—The latest summary prepared by the U.S. Bureau of Transport Economics shows that in the month of June 1,375,825 people were employed on American railways. This figure represented an increase of 3·43 per cent compared with June, 1946.

A SEVERN RAILWAY BRIDGE.—The Minister of Transport was asked recently if he would consider a scheme, which was being sponsored locally, to make the railway bridge across the River Severn, between Lydney and Sharpness, available also for road traffic. The Minister's reply said that the scheme had been considered on a number of occasions. Having regard, however, to the inevitable irregularity of such a service and to the small number of vehicles that could be conveyed, he did not feel justified in asking the railway companies concerned to construct the works necessary to enable such a scheme to be operated.

A NEW FORD "V.8" CAR.—On Thursday of last week, August 14th, the Ford Motor Company, Ltd., of Dagenham, announced that production had begun of an entirely new full five-seater car, the "V.8 Pilot." The new "V.8" Ford has characteristically British lines and is expected to make a big contribution to the export trade, provided sufficient materials for its manufacture in quantity can be allocated. It has an eight-cylinder engine of 2½ litres capacity, designed to develop 66 b.h.p. at 4000 r.p.m., which is stated to give a cruising speed of 70 m.p.h. and a fuel consumption of about 25 m.p.g. The engine is mounted at four points on rubber and drives through a three-speed and reverse gear-box, with synchro-mesh operation between top and second gears. Equipment is particularly complete and includes a car heater, a built-in jacking system and accommodation for a radio set. The vehicle weighs 3192 lb unladen and with tanks empty. It is understood that the Ford Motor Company will continue to build the light cars, for which there is still a big demand, and that expansion of production of the "Pilot" will not take place at the expense of steel quotas issued for its light car programme.

BIRMINGHAM RAILWAY BRIDGES.—The London, Midland and Scottish Railway has placed contracts for the reconstruction of the bridges carrying Navigation Street and Hill Street respectively over the railway lines near New Street Station, Birmingham. The existing bridges are to be replaced by two modern steel structures which will take three years to complete. Special measures which will be taken to minimise interference with road traffic include the erection of a temporary bridge alongside the existing Hill Street bridge, and the construction of the new Navigation Street bridge so that half the existing bridge will remain open for traffic until half of the new carriageway is built. The new Navigation Street bridge will be a 507-ton steel structure with a span of 132ft, and will have a reinforced concrete slab deck. The main girders will be transported to the site in six sections and erected on the closed half of the old bridge. After erection the girders will be supported at each end on temporary beds and the section of the existing bridge beneath them demolished. The girders for the new bridge will then be rolled into position on giant ball bearings and lowered on to permanent beds. On completion the first half of the new bridge will be opened to traffic and the remaining section of the old bridge closed for similar reconstruction. The new Hill Street bridge, which will also have a concrete slab deck, will have a span of 146ft and the steelwork will weigh 393 tons. Until its completion road traffic will be diverted over a specially built temporary bridge which is already in position alongside the existing bridge. Reconstruction will be carried out on the same principle as with the Navigation Street bridge, except that the whole of the old structure will be occupied and used as a base for main girder erection. The girders will be temporarily supported at each end and the old bridge completely demolished beneath them. Then the girders will be rolled into position, lowered on to permanent beds and the additional construction work carried out.

Air and Water

AMERICAN AIRCRAFT EXPORTS.—"Personal" aircraft manufacturers in the U.S.A. are reported to have shipped 174 machines to overseas countries in the month of June. The monthly average of this class of export in 1946 was 115 aircraft.

WATER TREATMENT PLANT FOR CHICAGO.—A water treatment plant, dealing with 950,000,000 gallons a day, to serve the central and north districts of Chicago, has been recommended to the City Council. *Engineering News-Record* says that separate plants located on each intake tunnel system were considered, but the economic study revealed that a single plant located east of Lake Shore Drive and north of Navy Pier would be preferable. Containing 55 acres, this site is adjacent to a district zoned for industry and commerce and is served readily with rail facilities. The proposed plant will take raw water from the Dever and Harrison cribs located in Lake Michigan, but during construction a shore intake will be utilised. Filtered water will be supplied to the central district tunnel system through a short connection to the shore shaft at Chicago Avenue. The north district system will be supplied through a new tunnel connecting the proposed filtration plant and the Wilson Avenue tunnel system.

CALEDONIAN CANAL.—The Ministry of Transport states that the Caledonian Canal has been closed for through traffic until further notice owing to a breach in the canal embankment 3 miles west of Fort Augustus. The eastern part of the canal, however, is open to traffic as far as Fort Augustus. No traffic can be accepted from the western end.

Miscellanea

STRIKES IN THE U.S.A.—In the first six months of this year, there were 2175 strikes in the U.S.A., 160 fewer than in the first half of 1946. The strikes which occurred in the first half of 1947 also involved fewer workers, and, according to reports, cost only 0·5 per cent of working time in all industries.

SHEET AND STRIP METAL USERS.—The annual general meeting and Autumn conference of the Sheet and Strip Metal Users' Technical Association will be held in London on Thursday and Friday, September 25th and 26th. Various technical papers will be presented and discussed, and a banquet will be held on the evening of September 26th.

GENERATION OF ELECTRICITY.—A written reply by the Minister of Fuel and Power gives the following details regarding the generation of electricity in Great Britain in 1946: generated by steam plant fired by coal, coke or oil, 96·99 per cent; by water power, 2·76 per cent; by oil engines, 0·13 per cent; and by waste heat and refuse steam plant, 0·12 per cent.

CANADIAN COPPER AND NICKEL.—During the month of May new copper production in Canada amounted to 20,432 tons, compared with 15,497 tons in May, 1946. In the first five months of this year, production of all forms of copper totalled 90,667 tons, compared with 77,472 tons in the corresponding period of 1946. Output of nickel in all forms in Canada during May amounted to 19,769,954 lb, compared with 20,043,186 lb in April and 14,733,775 lb in May, 1946. For the first five months of 1947 production totalled 96,433,449 lb, compared with 75,163,735 lb in the same period last year.

LECTURES ON PHOTO-ELASTICITY.—Two courses of lectures and laboratory training in photo-elasticity are to be given in the Engineering Faculty of University College, London, during the 1947–48 session. The first of the courses will cover the theory and practice of photo-elasticity, and is intended for students who wish to proceed to research work in the subject. It will occupy two hours a week throughout the session. The other course is to be a short one occupying one hour a week in the second term, and is intended primarily for fourth-year and post-graduate engineering students. The photo-elastic laboratories are being enlarged and will be available for research work. Fuller particulars of the courses can be obtained from University College, Gower Street, London, W.C.1.

APPLIED PHOTOGRAPHY EXHIBITION.—The Exhibition of Applied Photography which was organised recently in London by Kodak, Ltd., is to tour the provinces. It will be open at the People's Hall, Albion Street, Leeds, from September 8th to 12th; then goes to 244, Deansgate, Manchester, September 29th to October 3rd; McLellan Galleries, Sauchiehall Street, Glasgow, October 13th to 17th; Chamber of Commerce, Birmingham, October 27th to 31st; and at the City Museum, Queen's Road, Bristol, November 10th to 14th. The exhibition gives a practical demonstration of the usefulness of document copying, stress analysis, X-ray inspection of castings and welds, data recording, motion study, air survey, printing, and visual aids to teaching. Admittance is by invitation, which can be had from the Industrial Sales Department, Kodak, Ltd., Wealdstone, Harrow, Middlesex. There will, however, be one day at each centre open to the public.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Engineering and Marine Exhibition

Thursday, August 28th, to Saturday, September 13th.—London, Olympia.

Incorporated Plant Engineers

Wednesday, September 3rd.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Compressed Air Plant," D. Moreton. 7 p.m.

Friday, September 5th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham. Paper, "Earth Moving Machinery." 7.30 p.m.

Tuesday, September 9th.—MANCHESTER BRANCH: Engineers' Club, Manchester. "Construction and Maintenance of the Manchester Ship Canal," P. N. Reed. 7.15 p.m.

Thursday, September 11th.—NEWCASTLE-ON-TYNE BRANCH: Y.M.C.A., Connaught Rooms, Blackett Street, Newcastle-on-Tyne. "Job 99, Pluto," Mr. Alexander. 7.30 p.m.

Institute of Physics

Tuesday and Wednesday, September 16th and 17th.—The University, Leeds. Conference on Electron Microscopy.

Institute of Marine Engineers

Tuesday, September 9th.—85, Minories, E.C.3. Presidential Address, Sir Amos L. Ayre. Paper: "Steam Pipework Design in Ships." Lieut. (E) P. T. Heath. 5.30 p.m.

Institute of Metals

Tuesday, September 23rd, to Friday, September 26th.—Annual Autumn Meeting at Glasgow.

Institute of Welding

Thursday and Friday, September 11th and 12th.—Addison Restaurant, Olympia, W. Autumn Meeting. 2.30 p.m. and 5 p.m.

Institution of Naval Architects

Tuesday, September 23rd, to Friday, September 26th.—Autumn meetings at Portsmouth and Southampton.

Institution of Production Engineers

Monday, September 8th.—LUTON SECTION: Town Hall, Luton. Film Shows. 7 p.m.

Monday, September 15th.—DERBY SUB-SECTION: Art School, Green Lane, Derby. "Motion Study." Miss A. A. Shaw. 6.45 p.m.

Tuesday, September 16th.—WOLVERHAMPTON GRADUATES: Visit to Hobson Aircraft Company, Ltd. 8.15 p.m.

Wednesday, September 17th.—BIRMINGHAM SECTION: James Watt Memorial Institute, Birmingham. "Cold Upsetting and Thread Rolling." T. C. Parker. 7 p.m.

Thursday, September 18th.—GLASGOW SECTION: Visit to Anderson, Boyes and Co., Ltd., Motherwell. 7.30 p.m.

Monday, September 22nd.—COVENTRY SECTION: Great Hall, Coventry Technical College, Coventry. "The Effects of the Change in the H.P. Tax upon Motor Car Production Engineering." Sir Reginald Rootes.

Wednesday, September 24th.—WOLVERHAMPTON SECTION: Wisemore Schools, Walsall. "The Future Development of Machine Tool Design," J. H. Wilkinson. 7 p.m.

Friday, September 26th.—LIVERPOOL SUB-SECTION: Adelphi Hotel, Liverpool. Inaugural meeting and dinner. 7 p.m.

Manchester Association of Engineers

Wednesday, September 3rd.—Visit to the works of Mather and Platt, Ltd., Park Works, Newton Heath, Manchester.

Model Engineer Exhibition

To-day, August 22nd to Saturday, August 30th.—New Royal Horticultural Hall, Westminster, S.W.1.

North of England Institute of Mining and Mechanical Engineers

Saturday, August 23rd.—Neville Hall, Newcastle-on-Tyne, 1. Annual general meeting. Paper, "A New Approach to Roof Control," H. J. Perrins and J. R. Jenkins, 2.30 p.m.

Works Management Association

Friday, October 3rd.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester. Discussion, opened by A. P. Young.

SPECIALISED LECTURES FOR ENGINEERS.—The Yorkshire Council for Further Education is arranging courses of specialised lectures for engineers to be given during the 1947–48 session at the Huddersfield Technical College, the Leeds College of Technology, and the Keighley Technical College. The courses will cover the design and manufacture of gears; metallurgy for engineers; photo-elasticity for engineers; torque-speed characteristics of electrical drives, and works executive training.

Personal and Business

MR. J. WALKER has been appointed a director of the Morgan Crucible Company, Ltd.

DR. ING. E. ZUREK has been appointed managing director of John Yuille (Metal Works), Ltd.

MR. N. J. AMOS has retired from the position of Chief Engineer, New Zealand Government Railways.

MR. J. PATON and Mr. A. S. McNaught have been appointed directors of P. and W. Maclellan and Co., Ltd.

MR. J. R. COLLINS, A.M.I.C.E., has been appointed deputy water engineer and manager to the Watford Corporation.

ALUMINIUM UNION, Ltd., states that its address is now The Adelphi, London, W.C.2 (telephone, Temple Bar 3535).

E. H. JONES (MACHINE TOOLS), Ltd., has been appointed sole selling agent in this country for Kearney and Trecker machine tools.

THE COLONIAL OFFICE states that Mr. R. A. Mills and Mr. S. P. Roper have been appointed Assistant Controllers of Telecommunications (Engineering) in Malaya.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd., announces that Mr. A. H. M. Jacob has been appointed an executive director. Mr. R. F. Gyngell has been appointed secretary of the company.

VICKERS ARMSTRONGS, Ltd., has acquired the sole manufacturing and selling rights in this and other countries of the printing presses hitherto made by Walter Scott and Co., Inc., Plainfield, U.S.A.

THE LONDON AND NORTH-EASTERN RAILWAY COMPANY announces the following appointments:—Mr. W. Mackenzie, chief engineer for docks (North-Eastern and Great Central sections), in succession to Mr. A. Tulip, who is retiring; Mr. E. G. Brentnall, assistant chief engineer (signals); Mr. A. K. Terris, assistant engineer (London); Mr. R. E. Sadler, assistant to engineer (London); and Mr. M. B. Macrae, chief technical assistant (construction), engineer's office, London.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s. d.
B.I.O.S.		
JAP/PR/81 ...	Statistics on Production and Consumption of Pig Iron-Steel Ingots and Finished Steel in Japan and Korea	2 2
JAP/PR/374	Chemical Manufacture: Asahi Denka Kogyo K.K. (Asahi Electro-Chemical Co., Ltd.), Tokyo, Japan	1 1
JAP/PR/375	Chemical Manufacture: Mitsui, Gomei K.K. (Mitsui Partnership Co., Ltd.), Tokyo, Japan...	1 1
JAP/PR/402	Metallurgical Developments in Japanese Ordnance	5 2
JAP/PR/403	Japanese Metallurgical Research in fields allied to those of U.S. Ordnance	6 2
JAP/PR/650	Report on the Gold and Silver Mining Industry of Japan... ...	2 1
JAP/PR/683	The Livestock Industry of Japan	5 2
JAP/PR/728	Report on Electro-Chemical Industrial Co., Ltd., Tokyo, Japan	1 1
JAP/PR/732	Manufacture and Use of Caustic Soda and Chlorine (Oriental Soda Industry Co., Japan)...	1 1
JAP/PR/766	Fisheries Education and Research in Japan...	2 8
JAP/PR/779	Technological Survey, Water Supply, Electrical Prospecting Equipment for Exploring Geological Formations and Natural Resources	1 7
JAP/PR/781	Industrial Diamonds used by Diamond Tool Manufacturers in Japan	0 7
JAP/PR/908	The Imperial Forests of Japan ...	5 2
Classified List No. 2 ...	Consolidated list under Subject headings of all Industrialists' Reports on Germany published up to and including October 26, 1946	0 8
No. 3 ...	November, 1946.—Supplement to above list	0 3
No. 4 ...	December, 1946.—Supplement to the above list	0 3
No. 5 ...	January, 1947.—Supplement to the above list	0 3
No. 6 ...	February, 1947.—Supplement to the above list	0 3
Technical Index	Alphabetical Subject Index of Reports published up to and including July 27, 1946	5 3
Part 2 ...	August, September and October, 1946, supplement to the above Index	1 7
C.I.O.S. XXX-83.—An addendum to this report has been issued and is available at the Sales Offices of His Majesty's Stationary Office.		
C.I.O.S.		
XXVIII-31 ...	The X-ray Industry in Germany (amended): This report, originally published February 23, 1946, was withdrawn for correction...	3 2
B.I.O.S.		
415	P. J. Kipp en Zonen: Galvanometers	0 7
881	Conditions in German Aircraft Instrument Industry	4 8
1042	Methods of Manufacture of Envelopes, Fancy Stationery, &c., and Machinery for use in these processes	6 8
1096	Staple Fibre Tow-to-Top Conversion methods in Germany ...	14 4
1196	German Instrument Wire Industry	4 2
1202	Fuzed Quartz Manufacture in Germany	1 1
1204	Manufacture of Cellulose Acetate by the Methylene Chloride process with Acid Recovery and Wacker Anhydride process (Dormagen)	2 2
1218	Report on Linen Industry in Germany	17 10
1225	German Wire Goods Industry ...	1 1
1237	Engineering Grey Iron	13 3
1240	German Camphor Industry ...	7 2
1241	The Manufacture of p:p' Diaminodicyclohexyl Methane (Dicykan)	1 1
1242	Ball and Roller Bearings: Manufacturing methods at Five German Factories	11 3
1243	Manufacture and Applications of AW2 Resin...	1 1
1263	German Flame Hardening of Armour Plate and Flame Cutting and Flame Hardening of Sprockets for Armoured Fighting Vehicles	7 9
F.I.A.T.		
771	Clay Mining in the Westerwald District of Germany...	1 1
845	Research reports on Benzyl Chloride, Xylylenechloride Triethanolamine, Triethanolamine Fatty Acids Esters and Methylolacetaphenon	0 7
846	Products for the Leather Industry from Ethylenechloride and Xylol and through the Sulfurisation of Xylol	0 7
848	The Influence of Oxygen on the Chlorination of Methane	0 7
868	Trypaflavine, Surfen, P.60, and B voflavine	1 7
895	Progress in Time and Radio Frequency Measurements at the P.T.R., Heidelberg	17 10
905 ... ... (Supplement No. 1)	Determination of Suitability of Paraffin Mixtures for Conversion to Fatty Acids by Catalytic Oxidation	0 7
945	The Manufacture of Gamma-Butyrolactone at I.G. Farbenindustrie A.G. Ludwigshafen ...	1 7
946	The Manufacture of Thiodibutyric Acid at I.G. Farbenindustrie A.G. Ludwigshafen ...	1 1
B.I.O.S.		
Misc. 2	An Investigation of the German Leather Industry	13 3
Misc. 5	The German Magnesium Industry	9 3
Misc. 11 ...	Synthetic Detergents and Washing Agents	7 9
Misc. 12 ...	Emulsifying Agents	5 2
Misc. 13 ...	Tylose HBR, Cellapret, and Relantin	3 8
B.I.O.S.		
JAP/PR/215–311 ...	Report on Permanent Magnet Alloys produced in Japan... ...	2 2
JAP/PR/830	A Survey of Timber Control in Japan since 1941	5 2
JAP/PR/245	Japanese Air Force Textiles ...	1 7
JAP/PR/671	Production of the Fishing Industry of Hokkaido	1 1
JAP/PR/1444	Metallurgical Examination of Armour Plate from Japanese Type IF "Oscar" Mark II S.E. Fighter	1 1
C.I.O.S.		
XXXIII-57	German Open Hearth Furnace Refractories (Appendix No. 9 to C.I.O.S. Report XXXII-119)...	2 2
XXXIII-58	Steel Foundries (Appendix No. 13 to C.I.O.S. Report XXXII-119)	2 8

B.I.O.S. Information Section, 37, Bryanston Square, W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

A Seven-Day Journal

Prototype Avro "Tudor II" Wrecked

By the accident on Saturday of last week, August 23rd, to the prototype Avro "Tudor II" aircraft and the death of four of the six persons on board, British aviation has suffered a lamentable loss. Those killed in the accident included Mr. Roy Chadwick, technical director of A. V. Roe and Co., Ltd., and Mr. S. A. Thorn, the company's chief test pilot. An obituary notice of Mr. Chadwick is published elsewhere in this issue. It is understood that the aircraft was being tested at the company's Woodford airfield before being sent to Boscombe Down for official acceptance trials for British Overseas Airways Corporation. According to a statement issued by A. V. Roe and Co., Ltd., the aircraft dipped its starboard wing, which touched the ground about 300 yards after the take-off. The aircraft was at the time airborne. The wing struck a hedge and the aileron was torn off, the machine coming to rest about 200 yards farther on. The cause of the accident will be investigated at a Ministry of Civil Aviation inquiry.

"Enterprise Scotland 1947" Exhibition

On Monday, August 25th, the "Enterprise Scotland 1947" exhibition was opened at the Royal Scottish Museum in Edinburgh by the Duke of Gloucester. This exhibition has been organised to demonstrate the skill and enterprise of Scottish industry and the great developments taking place in bringing back the basis of Scotland's economy. In the main the exhibition is concerned with the lighter industries in Scotland as distinct from the heavy industries, which employ a third of the country's insured workers. Since the war considerable progress has been made in broadening the basis of Scottish industry by the introduction of new lighter industries, and over 300 enterprises have engaged to lease or erect factories which will provide employment for some 80,000 workers. The exhibition is a spectacle, not a trade fair, and is designed to show to the best advantage a selection of textiles, sports gear, leather goods, domestic appliances, toys, &c., now being made in Scotland. Careful preparations have been made in order that home and overseas buyers may complete their work quickly and easily. For this purpose a private view of the exhibition will be available to them every morning for one hour before the public is admitted. During these private views a trained staff with expert knowledge of the different sections will be present to answer questions and arrange contacts with the manufacturers of the various types of goods. Supplementing the exhibition there is a display in fourteen shop windows in Princes Street, Edinburgh, each window display depicting a subject of importance in Scottish life to-day.

The British Electricity Authority

At the end of last week, the Minister of Fuel and Power announced that Lord Citrine had been appointed Chairman, and Sir Henry Self and Mr. J. Hacking, Vice-Chairmen, of the British Electricity Authority. Other appointments to the Authority, made by the Minister, are Mr. E. W. Bussey, Dame Caroline Haslett, Sir William Walker, Lieut.-Colonel E. H. E. Woodward, and Mr. T. Johnston (*ex-officio* as Chairman of the North of Scotland Hydro-Electric Board). The provisions of the Electricity Act require four of the chairmen of area boards to serve in rotation on the Central Authority, and the Minister of Fuel and Power has invited the following to be Chairmen-designate of the area boards and in that capacity to serve on the British Electricity Authority as soon as these area boards have been set up:—Mr. J. Eccles, Merseyside and North Wales; Alderman W. Lewis, Midland; Mr. J. S. Pickles, South-West Scotland, and Mr. H. J. Randall, London. It will be recalled that Lord Citrine resigned from the National Coal Board when he was appointed Chairman of the organising committee for the electricity industry in May last. For twenty years, until 1946, he was the General Secretary of the Trades Union Congress. Sir Henry Self was Permanent Secretary to the Ministry of Production from 1942 to 1943, Deputy Chairman of the British Supply Council in Washington in 1945, and since 1946 has been Permanent Secretary to the Ministry of Civil Aviation. Mr. J. Hacking is the Chief Engineer to the Central Electricity Board.

Report on the Collision at Hallen Marsh

A report has now been issued on the inquiry into the collision which occurred on Tuesday, February 18, 1947, near Hallen Marsh on the Hallen Marsh–Pilning Low Level single line branch of the Great Western Railway. The collision occurred when the 9.20 Avonmouth-Salisbury freight train was accidentally diverted over the Pilning single line at Hallen Marsh junction and collided head-on with the 8.45 p.m. Cardiff–Avonmouth special freight train 1¼ miles from the junction. The collision took place at a combined speed of about 37 miles an hour and both engines and tenders were derailed and damaged, and twenty-six wagons were also derailed, a number of them being completely smashed. All six members of the train crews were injured. In his report Brigadier C. A. Langley concluded that responsibility for the accident rested primarily on the signalman on duty at Hallen Marsh, who accepted the Avonmouth–Salisbury freight train from Holesmouth Junction under full "line clear" with the junction points incorrectly set, and instructed the driver of that train to pass the main line starting signal at "danger" with the facing points set for the branch line. This signalman had, owing to a mistake of his own, jumped to the conclusion that his equipment had failed, and authorised the driver of the Avonmouth–Salisbury train to pass the starting signal when the junction points were incorrectly set. The driver of the Avonmouth–Salisbury train was also found partly to blame for not keeping adequate look-out after he had passed the signal at "danger," when he should have noticed the setting of the facing points which it was protecting.

The Model Engineer Exhibition

The twenty-second Model Engineer Exhibition was opened at the New Royal Horticultural Hall, Westminster, London, S.W.1, on Wednesday, August 20th. A very wide range of subjects is covered by the exhibits, although, as is probably natural, railway, aircraft and shipping models predominate. Some 400 models have been entered in the competition section of the exhibition, and the standard of workmanship is as high, if not higher, than in previous years. The skill, ingenuity and patience which has been put into the making of many of the models is particularly evident, and the efforts of many of the competitors is even more praiseworthy when it is remembered that but few of them are trained engineers. A particularly fine selection of models in the loan section of the exhibition range from a miniature man in armour to a model of H.M.S. "Implacable," which was made by members of the ship's crew. Historical models in this section include a colliery pit engine dating from 1862, and a model engine said to have been made by Richard Trevithick some 130 years ago. In the trade section a number of firms show a comprehensive range of tools, components and materials likely to be of use and some of which are specially designed for the model maker. A particular feature of the exhibition this year is the introduction of a 50ft diameter arena, round the outer circumference of which is arranged a track for model cars and a waterway for model speedboats. In previous years visitors have been able to inspect and admire many excellent models of racing cars, speedboats and aircraft, but now, with the introduction of the arena, they have an opportunity to see the models actually working. A number of interesting demonstrations are arranged daily on the track, which is being operated by members of the Society of Model Aeronautical Engineers, the Pioneer Model Racing Car Club and the Model Power Boat Association, and by members of the engineering trade. The exhibition closes to-morrow, Saturday, August 30th.

Transport Act Appointments

The Minister of Transport announced at the end of last week that under the Transport Act, 1947, he had appointed Sir Eustace Missenden to be Chairman of the Railway Executive and Lord Latham to be Chairman of the London Transport Executive. Sir Eustace Missenden, who is sixty-two, is at present general manager of the Southern Railway. He entered the service of the old South-Eastern and Chatham Railway Company in 1900, and was appointed assistant to the district superintendent, Eastern Division, in 1912. He later became traffic superintendent in the London District of the South-Eastern, and subsequently divisional operating superintendent, Southern Railway. In 1936, Sir Eustace was appointed traffic manager, a position which he continued to hold after taking up early in the war the duties of general manager. Lord Latham is fifty-eight and from 1940 to July last was leader of the London County Council. He has been a member of the London Passenger Transport Board since 1935.

Employment of British Shipping

The General Council of British Shipping states that the appointment of the committees to carry out the transitional administration of British shipping has now been completed. The Minister of Transport has already announced that arrangements have been made for the Council to take over, from October 1st, certain executive work connected with the allocation of British ships to Government and Government-sponsored shipping requirements hitherto carried out by the Ministry of Transport. The General Council has appointed a Shipping Advisory and Allocation Committee to assist in carrying out the duties delegated by the Minister of Transport and also to help in advising the Minister generally on the arrangements necessary to secure the maximum possible advantage from British tonnage. This Advisory Committee will have representatives of liner and tramp shipping and will be assisted by the General Council's Liner and Tramp Standing Committees. The offices of the Committee are at Cory Buildings, Fenchurch Street, London, E.C.3.

A Durham Colliery Explosion

The second major disaster in British coalfields in just over a week occurred about midnight on Friday last, August 22nd, when an explosion took place in the fourth north district of the Hutton seam in the Louisa Old Pitt, Annfield Plain, Co. Durham. A maintenance party was carrying out underground repairs at the time of the explosion and twenty-four men were working in the affected district. We regret to have to record that nineteen of the men were killed instantly, and that one of the remaining five who were badly burned has since died from his injuries. Rescue work, which was started immediately after the explosion, had to be carried on under very difficult conditions, but was none the less courageous and determined. The pit is said to be one of the oldest in Co. Durham and is situated on high land between the Derwent and Wear valleys. Normally, about 530 men are employed, and had a production shift been in progress in the seam affected by the explosion, this regrettable accident would undoubtedly have been much more serious.

Engineering and Marine Exhibition at Olympia

No. I

ABOUT four hundred firms and organisations are represented at the Engineering and Marine Exhibition at Olympia, which opened yesterday, August 28th. In the descriptive and Art Supplements which accompany this issue, and in the article below, we give particulars of some of the more interesting exhibits. In succeeding issues we hope to continue our account within the limits of space accorded to us.

English Electric Company, Ltd.

On the stand of the English Electric Company, Ltd., several photographs illustrate the many activities of the company in the field of heavy electrical engineering work, but the three main exhibits, apart from welding exhibits, are representative of the oil engine work of the company which is carried out at the Willans Works, Rugby, and at the Preston Works. We show in the accompanying Art Supplement the largest of these three exhibits, which consists of a 200-kW marine auxiliary generating set. This set is similar to those supplied by the firm to the Admiralty for installation in escort aircraft carriers. Attention may be drawn to the design of the fabricated steel bed-plate, which accommodates the engine at the centre, with the auxiliary pumps, coolers, &c., at one end and the generator and its ventilating gear at the other end. The engine installed with these sets is the firm's six-cylinder "K" type, which in the naturally aspirated range includes a series of engines with designed outputs of 165 b.h.p. to 440 b.h.p. at 600 r.p.m., in three to eight cylinders, and the "R.K." range, with outputs from 200 b.h.p. to 533 b.h.p. at 750 r.p.m., in three to eight cylinders. The same type of engine, pressure charged with an exhaust gas turbine, gives 330 b.h.p. to 660 b.h.p. in four to eight cylinders at 600 r.p.m. in the "S.K." series, and 400 b.h.p. to 800 b.h.p. in four to eight cylinders in the "S.R.K." series, running at 750 r.p.m. The constructional details of these engines, which have a bore of 10in and a stroke of 12in, are well known and have already been described in our pages.

Another interesting exhibit is that representative of the company's railway traction work and consists of a six-cylinder "K.T." engine, a type which has seen service on our four main line railways and has been employed on traction work in all parts of the world. The appearance of the engine with its three-point support at the end of the engine and on the generator feet can be noted from Fig. 1. On the stand the engine is shown complete with the driver's control desk and the control cabinet, such as forms part of the modern oil-electric locomotive. The engine is driven by an electric motor so that the unit can be seen in motion, and the engine is fitted with inspection doors on the crank case made of "Perspex." Another traction engine is representative of the company's smallest range of engines, the "H.T." and "S.H.T." types, which can be supplied with either normal induction or pressure charging. These engines have a bore of 6in and a stroke of 8in and are four-cylinder models with designed ratings of 242 b.h.p. and 303 b.h.p. maximum and 220 b.h.p. and 275 b.h.p. at the twelve-hour rating. They have been supplied for four-coach trains for service at Colombo, Ceylon. A considerable amount of technical information is now available concerning the operation of the traction engines referred to, both in train and shunting service. It is stated that in shunting operation work a cylinder liner wear rate of 0·00025in per 1000 hours' operation is a regular result, and that there is little wear of bearings and shafts. The piston ring life is extensive and after 20,000 hours of shunting service it is frequently found only necessary to replace the top piston ring.

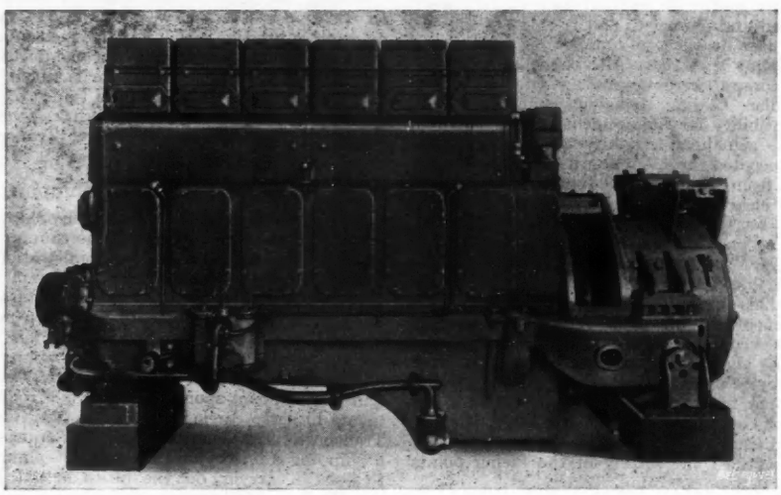


FIG. 1—SIX-CYLINDER 350 B.H.P. OIL-ELECTRIC SET—ENGLISH ELECTRIC

Ruston and Hornsby, Ltd.

An outstanding exhibit on the stand of Ruston and Hornsby, Ltd., of Lincoln, is one of the largest engines of the Ruston range, the six-cylinder marine type "Vox" engine which has a designed output of 1610 b.h.p. when running at the moderate speed of 435 r.p.m. A view of this engine in one of the firm's test bays is reproduced in one of the Art Supplement pages. The engine, which we have seen running, will be of special interest to marine engineers. It is representative of the series of engines ranging from five to nine cylinders covering outputs from 1340 b.h.p. to 2410 b.h.p. The engine operates on the four-stroke compression-ignition principle, with direct fuel injection, and the design incorporates an exhaust turbine-driven pressure charger. As a marine propulsion engine the "Vox" series is available as a unidirectional unit, working with oil-operated reverse reduction gearing for direct drives or for oil-electric installations in single or multiple form. All the engines of the series, with the exception of the five-cylinder unit, are available as direct reversing engines. The engine is moderately rated and is designed throughout in accordance with Lloyd's Register and other leading classification societies. By the adoption of a suitable number of engines either driving through gearing or electric transmission, power requirements up to propulsive outputs of 17,000 b.h.p. can now be catered for. As an industrial unit it is available for power station and industrial drives. Some leading particulars are tabulated below.

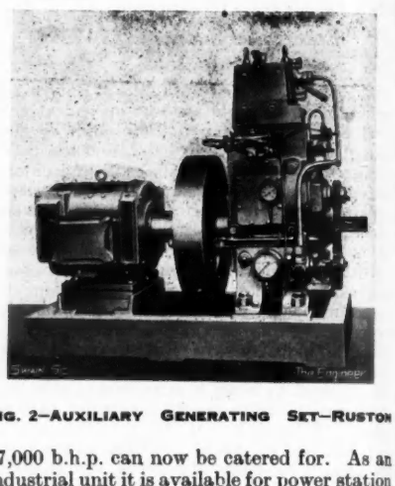


FIG. 2—AUXILIARY GENERATING SET—RUSTON

Design Particulars

Designed output	1610 b.h.p.
Number of cylinders	6
Bore of cylinders	17in
Piston stroke	18in
Running speed	435 r.p.m.
Rated b.m.e.p.	119 2 lb per sq. in
Mean piston speed	1305ft per min
Full load fuel consumption ...	0·37 lb per b.h.p.-hour

The engine embodies in its design the firm's long experience in the design and operation of land and marine engines, and includes many features which have proved their reliability over many years.

The cast iron bed-plate is of robust construction; it carries the main bearings for the crankshaft, and is machined for receiving the columns and securing the bed-plate to the engine seatings.

The housing comprises a cast iron entablature which is supported on separate columns, and the bed-plate, columns and entablature are held together by through-going bolts so arranged that four bolts take the working forces of each cylinder. The entablature is water-jacketed, and carries renewable cylinder liners, and also forms a support for the camshaft, the fuel pump operating gear and the pressure charger. The running parts of the engine follow generally Ruston standard practice.

The liners are made of high-grade cast iron and are ground, and then finished by honing. A two-section crankshaft is employed, of solid forged steel, each section having a spigoted joint on the top

of which the camshaft driving chain wheel is carried. A solid forged coupling at both ends of the crankshaft for coupling to the fly-wheel and the propeller shaft or reducing and reversing gear is provided. Each cylinder head carries an overhead inlet and exhaust valve, a fuel valve, and a starting air and relief valve. The cylinder head and the valve cages are effectively water-jacketed, and the cages are furnished with renewable guides. The pistons have a separate alloy head and a cast iron skirt, and are oil-cooled. They carry six pressure rings and one oil scraper ring.

The fuel injectors are of the spring-loaded, multiple-hole pattern, which, it is claimed, are very simple in design and easy to maintain and recondition. They have a self-centring nozzle, and the fuel inlet connection is fitted with an edge-type filter. There is a separate fuel pump for each cylinder, which is conveniently mounted on the top of the entablature alongside the cylinder it serves. Air starting is used with master valves controlling timed air admission. The centrifugal governor is gear driven at the fly-wheel end of the engine and controls the fuel pumps. Hand-operated control gear is also provided. The cast iron exhaust manifolds are attached directly to the cylinder heads, and are connected through expansion joints to the pressure charger, which is of the exhaust-turbine-driven type. The cylinder liners and heads are arranged for cooling with distilled water with independent water-circulating pumps. The distilled water is cooled by a heat exchanger system incorporating independent sea-water pumps.

The engine controls are conveniently situated for ease of operation, and besides the starting and control levers, there is a control gauge board, including pressure gauges for the oil system of the engine, the piston cooling oil pressure, the gauge for the cooling water system and the starting air gauge, also an electric tachometer, and exhaust thermometers. The engine we have described has not been exhibited before.

Other Ruston exhibits include a 200 b.h.p., six-cylinder engine of the marine type coupled to an oil-operated reverse reduction gear, while another six-cylinder unit is the 60 b.h.p. to 90 b.h.p. marine engine with reverse gear. Auxiliary generator sets include a 167 b.h.p., five-cylinder engine directly coupled to a 100-kW dynamo, also the single engine generator set shown in Fig. 2, and a twin-cylinder 15 b.h.p. engine directly coupled to a 5-kW dynamo and an air compressor. Some other models of small engines and boilers are also on view.

Quasi Arc Company, Ltd.

One of the interesting exhibits shown by the Quasi Arc Company, Ltd., Bilston, Staffs, is the portable diesel engine-driven welding generator set which is illustrated in the accompanying Art Supplement. This portable set ("DE 300") incorporates a Ruston two-cylinder diesel engine directly coupled to a Quasi Arc welding generator.

The generator is capable of providing an overall welding current range of 20A to 300A, and the equipment embodies the latest form of Quasi Arc dual control, which gives sensitive control of both striking voltage and welding current, allowing the operator to choose the particular welding characteristic best suited to the class of work in hand.

The machines, mounted on a common framework, are totally enclosed in a weatherproof housing fitted with sliding louvred doors to give easy access to both engine and generator controls. With its generous rating and weatherproof construction the set is designed to be specially suitable for operation overseas under arduous climatic conditions.

Another equipment to be seen on the same stand is the portable lightweght petrol engine-driven arc welding set ("PE 250"), which is illustrated in Fig. 3. This equipment has been developed to meet the increasing demand for a self-contained arc welding set capable of being dismantled and reassembled rapidly for easy portability over rough country. For hand haulage where conditions are suitable, the set is provided with a drawbar and pneumatic-tyred wheels.

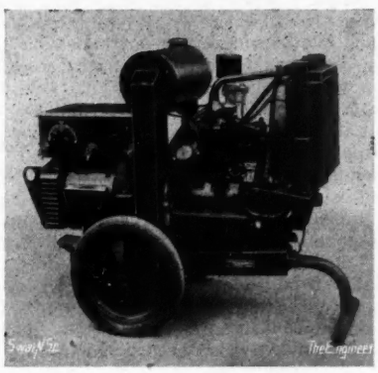


Fig. 3—Petrol Engine Driven Welding Set—Quasi Arc

As illustrated herewith, the equipment comprises a four-cylinder petrol engine directly coupled to a d.c. welding generator having a drooping characteristic with self-stabilising arc control. The two machines are mounted on a substantial steel base and the set is supplied with a sheet aluminium housing for protection. To simplify portability over rough country the set can be dismantled simply into three sections, each of which is designed for easy transport by four men. The overall welding current of the generator is 20A to 250A and the open circuit voltage available for striking the arc is 70V.

Included in the standard range of electrodes exhibited on the same stand are three types of electrodes developed recently. For the vertical and overhead welding of mild steel the new "Vortic-B" electrode is generally similar to the "Vortic" electrode, but has a specially robust covering, which makes it suitable for awkward positional and general site welding. The second new electrode, which is known as "Weldeep," is suitable for downhand deep penetration of mild steel, using currents within the normal range of standard welding sets. The third electrode, "Ferroloid No. 2," is designed for the repair of cracks and fractures in cast iron without the necessity for preheating.

Sciaky Electric Welding Machines, Ltd.

A variety of machines for general and specialised welding work is being shown by Sciaky Electric Welding Machines, Ltd., Slough, Bucks.

Among the advantages claimed for one of these machines—known as the "PAG 300" automatic indexing projection welding machine—are the increased output resulting from high welding speed and the superior weld with a minimum of distortion that is obtained by accurate jigging. This plant, which is illustrated in the accompanying Art Supplement, is capable of producing up to forty-five projection welded components per hour. The parts to be welded are operator-fed to the ten welding jigs mounted on a rotary indexing table arranged for speeds from fifteen up to forty-five welds per minute. A Geneva movement, driven by an electric motor through a steplessly variable gear-box, provides the intermittent movement required by the indexing table. At the conclusion of the welding cycle the components are automatically ejected. Primary current control is achieved by a B.T.H. ignition contactor panel, while resistance capacitance circuits control the timing sequences.

The machine is completely interlocked, so that if any operation is faulty or is incomplete when the table is ready to be indexed to the next welding position, the motor is switched off and a brake is applied to bring the machine to a standstill. If the machine is stopped merely because of the slowing down of a certain operation, such as the return of the top electrodes, then, immediately this operation has regained step with the rest of the mechanism, the motor is automatically started up again. It follows that, after any such stoppage, the indexing and welding sequence will recommence without any resetting of the machine.

Another machine exhibited is the 7kVA air-operated machine for bench mounting (Fig. 4), which is suitable for controlled

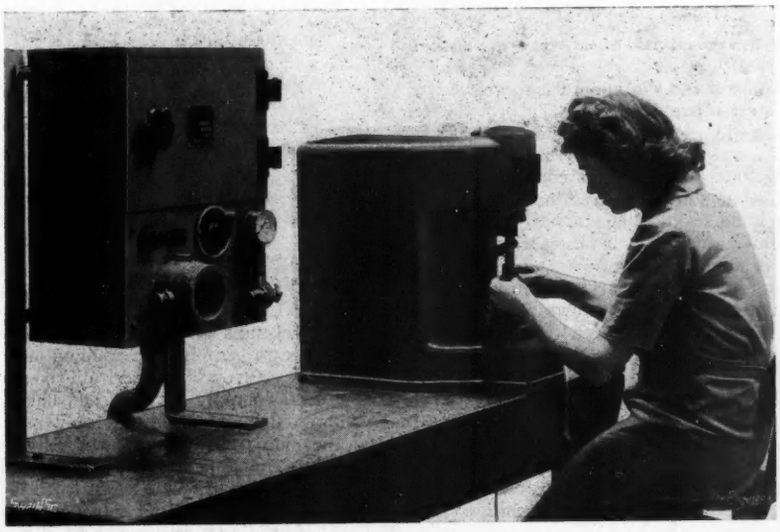


Fig. 4—Bench Spot Welding Machine—Sciaky

spot welding, hot riveting and brazing. It is capable of spot welding up to two equal thicknesses of $\frac{1}{16}$in mild steel sheet and of hot riveting up to $\frac{1}{2}$in diameter rivets. The equipment has an electrode stroke of 1$\frac{1}{2}$in and it can exert an electrode pressure ranging from 115 lb, at 20 lb per square inch in line pressure, up to 380 lb, at 80 lb per square inch line pressure.

Welding times are controlled by the Sciaky resistance-capacitance time control unit, which, it is claimed, makes possible very accurate weld timing over a wide range. Once the welding sequence has been initiated by depressing the electrical foot-switch, the machine will automatically complete the weld even if the foot-switch is released prematurely.

A special pressure switch is fitted to ensure that full pressure is applied to the work-pieces before the welding current is switched on, and that this pressure is maintained until the current has been switched off, so that burning of the metal surface is avoided. At the end of the weld timing interval the current is automatically switched off and the electrodes come apart.

Siemens Schuckert (Great Britain), Ltd.

Electric welding machines, furnaces and industrial X-ray equipment are exhibited on the stand of Siemens Schuckert (Great Britain), Ltd., Brentford, Middlesex.

One of the welding machines (Fig. 5) is an air-operated universal seam welder for

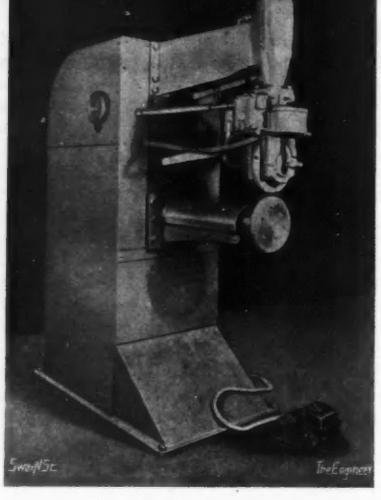


Fig. 5—Air-Operated Seam Welder—Siemens

longitudinal and circumferential welding of mild steel up to 18-gauge. To provide the modulated current necessary for welding air-tight seams the machine incorporates a modulator. When used in conjunction with an ignition panel the machine can be used for welding stainless steel.

High-conductivity hard-wearing copper alloy is used for the upper and lower electrodes, each of which is 9in in diameter, allowing more than 2in for wear. Both electrodes, the lower arm and the main transformer secondary coil are water cooled. The machine is fitted with 24in arms and is suitable for welding speeds from 2ft to 12ft per minute.

The modulator constitutes a simple and effective method of providing the required interruptions to the welding current. Modulation is achieved by superimposing a varying rotor voltage upon the mains voltage supplied to the transformer, which results in a series of voltage peaks, during which welding takes place.

At the other end of the scale is a smaller machine—the 4kVA bench spot welder—which is illustrated in the accompanying Art Supplement. This equipment is pedal operated and it is suitable for spot welding wire and sheet up to 22 S.W.G. An interesting point about the design of this machine is that the upper electrode moves, like a plunger, parallel to its length.

Philips Lamps, Ltd.

A comprehensive range of equipment for arc and resistance welding is included in the exhibits shown by Philips Lamps, Ltd., Century House, Shaftesbury Avenue, W.C.2. The display includes a recent addition to this company's products—a capacity storage spot welding machine, suitable for welding speeds up to eighty spots per minute on light alloys from 19 to 14 S.W.G.

This welding machine (type " E 1505/6 "), which is illustrated in one of our Art Supplement pages this week, embodies some interesting principles in its design. A condenser power storage unit forms part of the equipment, so that during operation the spot welder is isolated from the power supply while the energy for the welding cycle is being delivered from the condensers in the storage unit. In addition, provision is made for accurate control of welding heat to reduce the welding time and for electrode pressure control to ensure a quick forging action; the machine therefore satisfies two of the important requirements in the technique of welding light alloys.

Welding energy for operating the capacity storage spot welding machine is derived from a bank of twenty-eight electrolytic condensers, each of which has a capacitance of 1000μF, making available a maximum capacitance of 28,000μF.

The condensers are suitable for a maximum potential of 500V, which is obtained from a mains-fed mercury arc rectifier. The input to the mercury arc rectifier from the mains transformer is at 400V, three-phase, 50 cycles per second, the maximum demand being 60A at 0·8 power factor. A phase shift device controls the grid of the rectifier, which delivers to the bank of condensers a smoothly variable voltage of from 120V to 500V. Controlled variations in the energy output available for welding are brought about by increasing or decreasing the voltage range of the rectifier between the limits of 120V and 500V. This arrangement, which uses the storage capacitance of condensers to supply the welding energy, constitutes a favourable load from the standpoint of the supply undertaking, since the maximum demand is considerably reduced and the high peak currents, normally associated with single-phase working, are avoided.

Important conditions to be satisfied in the spot welding of aluminium alloys are precise control of welding pressure and rapid follow-up of the collapse of the material being welded. In normal machines it is difficult to ensure that collapse of the material during welding will be followed up instantaneously by the welding head to ensure constant pressure. To compensate for the effects of inertia the machine under review has a spring-loaded welding head which is similar in design and operation to the engineer's spring-loaded centre punch. Pneumatic pressure forces the electrodes together and the electrodes are spring suspended. A large diameter coil spring allows the welding head to rise, and welding is initiated at a predetermined pressure. The theory underlying this design is that a spring exhibits constant deflection at a given pressure, and this form of suspension has the effect of damping out the effect of variations in air supply pressure. The spring pressure is adjustable through the medium of a calibrated screw which allows the force between the welding electrodes to be smoothly and precisely varied between 200 lb and 1000 lb. This arrangement also satisfies the second requirement, for the spring-loaded electrodes, with their low inertia, are able instantaneously to follow up collapse in the weld material.

The machine, as illustrated in the accompanying Art Supplement, is fabricated from steel plate and the transformer is housed under a louvred sheet metal cover. To ensure rigidity the secondary arms are of welded steel construction with cast copper conductors for carrying the secondary current. The condenser storage unit or power pack forms a separate assembly weighing approximately 9 cwt. The auxiliary services required for the spot welder are a supply of dry, clean air at 80 lb per square inch, and a supply of 2 gallons of cooling water per minute.

C.A.V., Ltd.

The exhibits of C.A.V., Ltd., Acton, London, W.3, are representative of the two main groups of the company's products—fuel injection equipment and low-voltage electrical equipment—for a wide range of marine and industrial engines.

The fuel injection equipment includes the " Pintaux " nozzle, which is designed to give easier starting from cold and improve general running of engines. It is applicable only to the Ricardo " Comet " type of cylinder head, which is characterised by a partially separate spherical combustion chamber communicating with the cylinder by means of a tangential passage or throat. With this design, on the compression stroke of the engine air is forced from the cylinder through the throat into the spherical chamber, where a violent rotary swirl is established. The fuel is sprayed into this swirl and complete mixing of the fuel and air to obtain good combustion is ensured.

To facilitate easy cold starting of engines using this type of head it has been the practice in the past to fit a heater plug into the chamber to heat the compressed air to a temperature sufficient to ignite the fuel spray

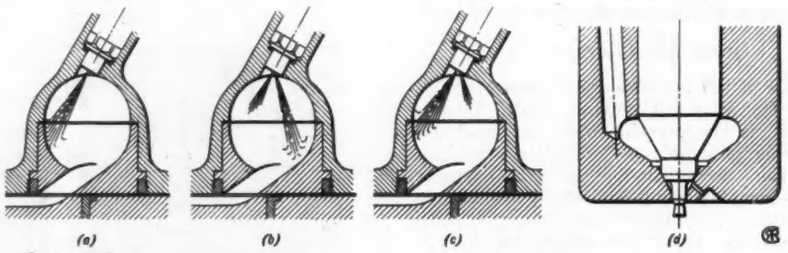


Fig. 6—Spray Sequence and Nozzle Design—C.A.V.

readily during the starting sequence and before the engine has received any internal heat from combustion. The "Pintaux" nozzle has been developed primarily to enable easy cold starting to be obtained without the use of heater plugs.

With the normal type of pintle nozzle the spray is directed as shown in diagram *a*, Fig. 6, as this spray path used in conjunction with the type of air swirl created has been found to give the best all-round engine performance. Recent investigations, however, have established that the hottest zone of the chamber under starting conditions is outside this spray path and more to the centre of the spherical chamber, and that by spraying into this hot zone considerably improved cold starting could be obtained without the use of heater plugs. Unfortunately, it was found that when a spray path designed to give optimum starting conditions was used general engine performance was impaired.

The feature of the new nozzle is that on starting it directs the bulk of the fuel spray through an auxiliary injection hole to the hot zone of the combustion chamber, but after ignition occurs and the engine speed rises the spray is redirected through the pintle hole to that zone where optimum power performance can be obtained. The path of the spray under starting conditions is shown in diagram *b*, where fuel is spraying into compressed air at a pump camshaft speed of 100 r.p.m., and the whole of the spray is from the auxiliary hole. The spray path when running at a speed of 600 pump r.p.m. is shown in the third diagram *c*, where it will be seen that under running conditions, even though the bulk of the fuel is discharged in the path as shown in the first diagram, it is preceded by a small spray from the auxiliary hole, which acts as a pilot charge and reduces combustion noise.

The diagram *d*, Fig. 6, shows the new nozzle in section; the needle seating is above the auxiliary spray hole and there is an annular space above the seating. In operation, at starting speeds, the oil pressure in the annulus builds up during the pump delivery, lifting the needle from its seating and permitting a flow of fuel into the annulus below the seat from which the auxiliary hole leads. The needle is extended below the seat to fit into the comparatively large diameter pintle hole. At starting speeds the needle is lifted insufficiently to clear the pintle hole and the fuel is discharged through the auxiliary or starting hole. At running speeds, when the pressures in the fuel system are higher, the needle is withdrawn completely from the pintle hole and the bulk of the fuel is discharged through this hole.

Accurate Recording Instrument Company, Ltd.

A new tank level gauge and recorder made by the Accurate Recording Instrument Company, Ltd., Aric Works, Garth Road, Lower Morden, Surrey, is fully compensated for ambient temperature and pressure variations due to altitudes and any variations due to difference in tank and gauge heights. The instrument exhibited is mounted in a cast aluminium recorder case with a hinged and glazed lid and can be fitted with an electric or a hand-wound clock.

The mechanism of the instrument can be seen in the diagram Fig. 7.

The transmission from the float mechanism to the recording or indicating head is by means of a balanced twin hydraulic system, which is fully compensated for ambient temperature variations over a very wide range and for head effects due to differences of level in installation. The two capillaries A and B of the hydraulic system are, as far as possible, matched for length and bore and are each connected in the head of the instrument to one of a pair of matched metallic bellows. The bellows C is used for compensation purposes and the bellows D for indication. The compensating bellows is anchored at the top end and takes up the expansion due to a rise of ambient temperature by extending in a downward direction. The indicating bellows is connected at the top to the indicating or pen arm mechanism E, and at its lower end it is connected to the lower end of the compensating bellows through matched gear quadrants F. By this arrangement the lower extremities of each of the bellows move uniformly up or down for any change in ambient temperature, the top ends remaining stationary. A third bellows G fitted in a housing on top of the tank is connected to the indicating bellows in the head by the metal capillary tube B. Movement of these bellows indicates the change in position of the float and thus the change in tank contents. Mounted in the tank unit is a volumetric balancing chamber H connected to the compensating bellows in the head to complete the compensation system.

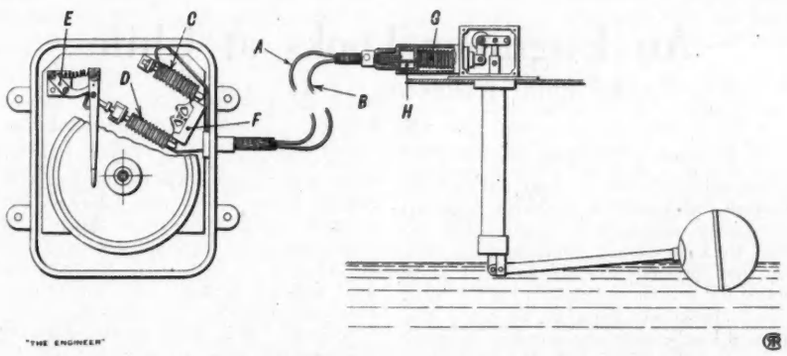


FIG. 7—DIAGRAM OF TANK GAUGE AND RECORDER—ACCURATE RECORDING

The twin systems are completely filled with a suitable fluid specially dried and degassed in order to produce a solid system free of air or vapour to give a transmission free from lag or backlash.

This mechanism is designed to give a constantly correct reading at all times and over a temperature variation −20 deg. to +100 deg. Cent. The system goes completely out of balance if the transmission is damaged and quickly indicates the fact when it is not working. As a recording tank gauge, the record is claimed to be so positive that the chart can be used as a stock ledger indicating contents at all times of the day and night and the precise quantity of any withdrawal or addition together with the time it took place.

Murex Welding Processes, Ltd.

The display of electric arc welding plant accessories and electrodes exhibited by Murex Welding Processes, Ltd., Waltham Cross, Herts, includes some of the company's standard products, together with an interesting piece of specialised equipment that has been developed to suit the stringent operating conditions that are experienced in oilfields. To work successfully in oilfields welding plant must be able to withstand extremes of temperature, altitude and humidity, and sand-laden air as well as the rough handling that is associated with very bad roads and semi-skilled labour.

In an effort to meet these requirements Murex Welding Processes, Ltd., has developed a mobile diesel-engine-driven arc welding set having a capacity of 400A. The drooping characteristic generator, which is designed to give a stable arc, is specially insulated to withstand tropical temperatures and humidity, and is fitted with a filter to remove sand particles from the incoming cooling air. Flexibly coupled to the generator is a four-cylinder Dorman type "DS" engine. It is stated that this unit has an ample power reserve to allow for losses due to high temperatures and altitudes. The equipment includes an air filter, lubricating oil cooler and a radiator designed to prevent the cooling water from boiling when the set is operating in ambient temperatures up to 125 deg. Fah.

To allow for transport over bad roads the makers have concentrated their efforts on a lay-out having a low centre of gravity. The overall height of the set from the ground is 5ft, the engine and generator shaft centre line is only 1ft 11in from the ground, and the track is 4ft 11in to ensure adequate stability over uneven ground.

The "mudguards" fitted over the 600 by 16 tyres are intended primarily to give protection from undue exposure to the sun. A lead-coated steel tank holds 16 gallons of fuel, which is stated to be more than sufficient for one day's running without refuelling. The portable current regulator is of mica and steel construction, and the design is claimed to have specially good heat dissipating qualities. To prevent pilferage of components on site the set is fitted with four steel roller shutters which can be easily raised or lowered and secured in the latter position by a single padlock.

Another equipment made by the same company is the 300A to 400A diesel-engine driven arc welding equipment which is illustrated in the accompanying Art Supplement. This single-operator set is a good example of the more conventional design of self-contained welding plant.

A. Reyrolle and Co., Ltd.

Several examples of arc welding machines are exhibited by A. Reyrolle and Co., Ltd., Hebburn, Co. Durham, the firm which now manufactures the well-known arc welding equipments that were previously made by J. H. Holmes and Co., Ltd.

Prominent amongst these exhibits is the company's latest single-operator welding generator, which embodies all the essential characteristics of the well-known Holmes machines, and has a drooping characteristic and a particularly rapid voltage recovery rate.

This generator forms an integral part of the a.c./d.c. motor-driven welding set which is illustrated on one of the pages in the accompanying Art Supplement. The motor is a high-overload capacity squirrel-cage

induction motor with a synchronous speed of 1500 r.p.m. The generator is rated for 200A continuous hand welding current in accordance with B.S. 638, and is capable of supplying 300A for intermittent welding.

Current control is provided by a snap-action rotary selector switch which provides coarse regulation in a series of definite steps, and a fine regulator concentrically mounted with the selector switch, giving continuous current regulation over the whole current range. In the engraving reproduced in the accompanying Art Supplement the operating hand wheel for the selector switch can be seen between the two meters; the knob, which is concentric with the hand wheel, controls the fine regulator. The selector switch has self-cleaning contacts with definite location at each step, and is graduated 20/40A, 40/70A, 70/120A, 120/200A and 200/300A.

The control box, which is mounted on the top of the set, houses the motor starter in addition to the selector switch with the associated resistance and the fine regulator. The motor starter is a push button operated air break contactor having thermal overload protection and arranged for star-delta or direct-on starting as required. Moving coil 2½in scale flush mounting instruments—an ammeter and a voltmeter—can be supplied, if required, as extras.

Erratum.—In the caption to Fig. 5 of this week's Supplement read "Honeychrome" for "Honeycomb."

(To be continued)

An Engineer Looks at Chile

By ROLT HAMMOND, A.C.G.I., A.M.I.C.E.

No. I.

Historical Background

IN the early sixteenth century days of the Spanish *conquistadores* in Latin America, those hardy adventurers found little to attract them in Chile; there was no gold, silver, nor precious metals to whet their appetite for wealth and power, no mythical Eldorado beckoned them on to brave the perils and hardships of the arduous overland march across the towering Andes.

Southern Chile, commonly known as the Straits of Magellan, was discovered in 1520 by Fernando de Magallanes; the northern end in 1535 by Diego de Almagro, who invaded the country from Peru with a party of Spanish explorers. Few volunteers were found to follow the first conqueror of Chile, the intrepid Pedro de Valdivia, who founded Santiago in 1541 and Concepción in 1550. War with the fierce and intractable Aracaunian Indians continued until the second half of the nineteenth century, yet in spite of this long and bitter struggle and lack of obvious treasure the country exerted a strong emotional and physical appeal on the conquerors by reason of its close resemblance to Andalusia, the fertile and beautiful region of Southern Spain.

The Spanish invasion took place in two distinct phases: during the sixteenth and seventeenth centuries most of the invaders came from Southern Spain, where Moorish blood and influence have always predominated. In the second invasion, from the eighteenth century onwards, more and more Spaniards from Northern Spain went to Chile, who, according to the Chilean writer Luis Thayer Ojeda, were of a very different character from the Southerners, more phlegmatic and less inclined towards adventure.

The brave and warlike qualities of the Aracaunians drew the admiration of their conquerors, expressed in the epic sixteenth century poem "La Aracauna" by Alonso de Ercilla y Zuniga. In those early pioneering days there was complete mixture of races as between the Spanish invaders and the native Indians; history records that in one week, during the year 1580, sixty children were born in a frontier post established for protection against raids by Aracaunians in which 160 Spaniards were stationed. Thus the original population of Chile in Colonial times was largely of *mestizo* type in which the warlike qualities of two virile races were perfectly blended. The profound and lasting influence of this cross-breeding has been observed in the modern Chilean, famed for his independent spirit and love of freedom, his bravery and his loyalty.

The Colonial period lasted until 1810, when relative peace was established with the Aracaunians; this was followed by the struggle against the rule of Spain, national emancipation being finally achieved in 1818. Britishers were well to the forefront in this fight against tyranny and oppression, the first administrator bearing the name of O'Higgins. It is particularly interesting at the present time to record that Arthur Goodall Wavell, grandfather of the present Lord Wavell, was closely connected with the fight for Chilean independence; in 1820, already famous for the part which he played in the Peninsula campaign, Wavell offered his services to the Chilean army and was appointed a Colonel of Infantry by O'Higgins. He eventually became Deputy Commander-in-Chief of the Chilean army. Like his famous grandson, Wavell proved to be as able an administrator as he was a soldier, being responsible for the forging of economic and political links between Great Britain, Chile and the other Latin American Republics. As soon as Chilean Independence had been assured and the army placed on a sound administrative basis, O'Higgins sent Wavell on a special mission as Chilean delegate to help Mexico in her fight for freedom.

Lord Cochrane

The Chileans closely resemble ourselves in their love of the sea, for Chile has a long coastline and has always looked with pride on her navy and mercantile marine. In 1817 the Chilean Government invited that adventurous and resourceful sailor, Lord Cochrane, son of the Ninth Earl of Dundonald, already famous for having been dubbed "The Sea Wolf" by Napoleon, to command the Chilean Fleet. He was created "Vice-Admiral of Chile, Admiral and Commander-in-Chief of the Naval Forces of the Republic," and sailed northwards from Valparaiso on January 16th, 1819, his command comprising seven vessels with a total armament of 220 guns.

At the Peruvian port of Callao lay the Spanish frigate "Esmeralda," 44 guns, pride of the fleet and backed by a total armament of more than 500 guns, which included shore batteries. Cochrane, with that original and daring outlook for which he was noted, planned a surprise attack on the frigate during Carnival, when men's minds were diverted from concentrating entirely on warlike matters; he seized the island of San Lorenzo and proposed that the Chilean Government should urge the production of rockets, in his opinion the most effective weapons with which to attack the enemy fleet. Two days were spent in constructing rocket rafts and lifebelts, but there had been sabotage by the Spanish prisoners set to the task of filling the rockets; they had succeeded in mixing sand with the powder!

It is interesting to speculate what might have been the future trend of naval warfare in those days had the Cochrane plan succeeded, for these new weapons might well have revolutionised tactics. In many other respects Cochrane was ahead of his time, for his original mind was imbued with a passion for scientific research in the fields of physics and chemistry; he is reputed to have been responsible for introducing the smoke screen. His later expeditions were rewarded with success, his crowning achievement being the annexation of Valdivia, which gave Chile complete independence and paved the way towards the establishment of the Republic. Cochrane died in London in 1860 and is buried in Westminster Abbey, close to the tomb of the Unknown Soldier of the 1914–18 war; *The Times* obituary notice referred to him in the following terms:—

> "History can produce few examples of such a man or of such achievements. There have been greater heroes, because there have been heroes with greater opportunities, but no soldier or sailor of modern times ever displayed a more extraordinary capacity than the man who now lies dead. He not only never knew fear, but he never knew perplexity, and was invariably found master of the circumstances in which he was placed."

It would be difficult to gauge accurately the profound influence of this great and talented man in the building of modern Chile, but that he was one of the chief architects of the foundations of this state will be universally admitted; his name will ever be reverenced by Chileans, and indeed, by many thousands of Latin Americans.

Geographical Background

Chile is often described as the Ribbon Republic by virtue of its long, narrow shape; the total length of the coast is nearly 3000 miles, and the width is in some cases less than 100 miles. On the landward side the Andes tower to a height of 25,000ft, descending steeply to the sea; a recent writer has referred to the topography of Chile as "geography gone mad." In an area of 286,397 square miles there were, according to statistics of 1938, some 4,677,089 persons; the population of the capital city of Santiago was in the same year 829,830, and the total railway mileage 5444.

Chile is divided into three distinct and well defined zones; in the north arid sandy deserts predominate, but this is a region of vast mineral wealth, in which copper and nitrate of soda are the most valuable deposits. In the central region there are fertile valleys, watered by streams and rivers, and several important industrial districts. The third zone is a vast archipelago of virgin forest land, where sheep and cattle are raised in large numbers. The desert country has been likened to North Africa, the central district to California, and the southern zone to Norway.

The Mining Industry

The chief industry of Chile is mining, and some of its problems have been reviewed recently by Correa*. The Chilean mining

* "La Mineria en Chile y su fomento oficial" ("Mining in Chile and its Encouragement by the Government"). Article by Cesar Fuenzalida Correa in *La Ingenieria* for May, 1944.

industry, writes Correa, is divided between the large companies backed by American capital and the small concerns owned and operated by Chileans. The importance of the latter is illustrated by the fact that the gold mines employ 13,000 workers and the copper mines 9000; multiplying by five to allow for the dependents of these employees it will be seen that more than 100,000 individuals benefit from this industry. Moreover in gold mining the annual output of both high and low grade ores is about 600,000 tons, yielding 7,000,000 grammes of gold with an approximate value of 320 million Chilean pesos. Annual output of high and low grade copper ores amounts to 700,000 tons, yielding 25,000 tons of refined copper worth about 200 million Chilean pesos. To these figures must be added the value of the silver contained in both copper and gold, representing 39 million Chilean pesos. Thus the mining industry, with a total value of 560 million Chilean pesos, is an important factor in the economic structure of modern Chile.

Mining Credit Bank

The establishment of the Mining Credit Bank had two main objects, namely to compete in the market with foreign ore buyers who bought only the very highest grade ores for export to the United States, and also to buy low grade ores in order to encourage the exploitation of hitherto neglected deposits; the experience thus gained would be of material help to individual miners. The principal object of eliminating the foreign buyers was to stop their abuse of market conditions, since the three buying houses established in the country divided the country into zones and thereby controlled prices.

It has, therefore, been a primary object of the Mining Credit Bank to install buying agencies operating in competition with the foreign buyers, establishing a convenient commercial tariff for the miners and paying them for both copper and gold ores. The bank, when it first began buying low grade ores, also installed enrichment plants in order to increase the market value of the ore; these plants have a monthly capacity of 11,000 tons of gold ore and 8000 tons of copper ore.

The gold is delivered to the treatment plant in two forms: high-grade concentrates, afterwards sold to foreign buyers and to the national smelting plants in the centre of the country; or as precipitates, later converted to metallic gold in refineries and at present sold to the Argentine Republic. The installation of these enrichment plants has brought about an intensive development in the mining of low grade ores previously unworked, with the result that mines beginning with low grade copper and gold ores end by providing high grade ores of considerable commercial value.

It often happens that access roads to mines are nothing more than cart tracks; the bank has therefore provided road-making equipment to solve the problem of road transport. New roads have been built in the development of a new mining district. Later, when the mine shows promise and increases in depth, the bank provides hoists, drills and other essential equipment at cost price, and four years' credit is granted for eventual payment.

In the desert country mines are often without water and the bank has therefore made arrangements to supply free water to mining communities in this region. For example, at Pueblo Hundido the bank has an enrichment plant, the operation of which was seriously hampered because only salt water could be obtained from the river for the flotation plant; this water was quite unsuitable for the miners. The bank, therefore, supplied piped water to Pueblo Hundido, Pueblo del Salado and Chanaral at a cost of 12 million Chilean pesos.

In certain districts where there is considerable mining activity, there is inadequate power for developing local industries. Thus in Andacollo, where there are many gold washeries and fifty-two small amalgamation plants, the bank has installed a power station of adequate size.

This brief review of the present state of the Chilean mining industry by an eminent South American authority clearly indicates that great efforts are being made in Chile to exploit her natural resources to the full, and it also shows the lengths to which the Chilean Government is prepared to go in order to encourage and develop mining.

Mechanical Equipment

From an engineering standpoint, a great deal of interesting and useful experence has been gained in the operation of mechanical excavators at the opencast* mine of Chuquicamata, described by William H. Goodrich in *The Mining Congress Journal* for December, 1926. The ore body at this mine is a coarsely crystalline quartz-felspar rock; in the original mining method, benches from 100ft to 200ft high were opened up, since reduced in height to between 40ft and 50ft.

For drilling the vertical bench holes preparatory to blasting electrically operated churn drills are used. On the lower benches, where the rock is very hard, the holes are 8in diameter, spaced at 12ft centres and sunk to 18in below the working level. Toe holes are used in conjunction with the bench holes, where experience suggests their employment; these are drilled to an average depth of 24ft and the charges therein are fired, in conjunction with those in the bench holes, as one complete shot. The length of a series of shot holes along a bench varies from 300ft to 2500ft, the quantity of rock blown down varying from 70,000 to as much as 1,000,000 tons at a time.

More than twenty mechanical shovels are employed, the majority of them being electrically driven machines of the American

Table I.—*Period, Five Months*

Type of shovel.	Capacity of bucket cu. yd.	Current.	Tonnage for eight hours.	
			Ore.	Waste.
Railway	4	D.C.	1483	1521
Railway	4	A.C.	1574	1488
Long jib, full circle	8	D.C.	2194	1383
Long jib, full circle	8	A.C.	2393	1309

railway type, with buckets of 4 cubic yards capacity. There are also large crane type shovels with long jibs and buckets of 8 cubic yards capacity, full-circle short jib quarry type shovels with buckets of 4 cubic yards capacity and oil-engined shovels with buckets of 1 cubic yard capacity. Tables I, II and III give their performance.

Table II.—*Period, Three Months*

Type of shovel.	Capacity of bucket cu. yd.	Current.	Tonnage for eight hours.	
			Ore.	Waste.
Railway	4	D.C.	1649	2011
Railway	4	A.C.	1724	1592
Long jib, full circle	8	D.C.	2229	—
Long jib, full circle	8	A.C.	2603	2088

Certain interesting conclusions can be drawn from these results. Outputs indicate that there is very little to choose between alternating and direct current power systems, with a slight balance in favour of the former. As regards comparison between the railway type of shovel and the long jib full-circle shovel, although the latter have double the capacity of the former and are also three

Table III.—*Period, Ten Months*

Type of shovel.	Capacity of bucket in cub. yd.	Tons per shift of eight hours.	Current consumption, kWh per ton	Per cent of digging time.
*Railway	4	1629	0·3673	66·8
†Railway	4	1391	0·3111	50·7
†Railway	4	1825	0·2956	72·9
†Short jib, full circle	4	1724	0·2884	74·2
*Long jib, full circle	8	2271	0·3763	53·5
†Long jib, full circle	8	2109	0·3356	70·7

*A.C. †D.C.

times as heavy, the output is only about 50 per cent greater. The longer jibs and bucket arms of the larger machines demand greater power for their rotation.

In spite of the fact that the railway type shovel—incidentally of the same design as the old "tower navvy," many of which were built in this country by Messrs. Ruston and Dunbar towards the close of last century—is much faster in its slewing action than the full-circle navvy, because it has to slew only the jib and bucket arm, the full-circle machine has been found to hold its own on this mine. There is, however, a saving of from 10 to 15 per cent in favour of direct as compared with alternating current.

It is both interesting and surprising that the short jib full-circle shovel gives the better result, bearing in mind the greater weight which has to be revolved in the full-circle machine. The greatest current consumption is shown on the long jib machines, but the difference is not so great as might be expected, considering the heavier revolving portion and the larger working ranges.

Both the long and short jib full-circle machines show up to advantage as regards percentage of digging time, but since they are both newer machines, this fact must be taken into account. Results indicate that 75 per cent can be taken as the maximum percentage of digging time to be expected; 70-ton wagons are used for the transport of ore and air-operated dump cars of 20 cubic yards capacity for the waste.

The Copper Industry

A general picture of the Chilean copper industry has been given by Tarring†. Chile was the world's largest producer of the metal in the early nineteenth century, but in 1881 her production was surpassed by that of the United States. At present Chile provides about one-sixth of the total world output of new copper, the bulk of her production coming from three companies, namely, the Andes Copper Mining Company at the Potrerillos mine, Atacama Province; the Braden Copper Company, which owns the El Teniente mine in the Province of O'Higgins and the Chile Copper Company, with its mine at Chuquicamata, to which we have already referred, in the Province of Antofagasta. All three are controlled by large groups in the United States.

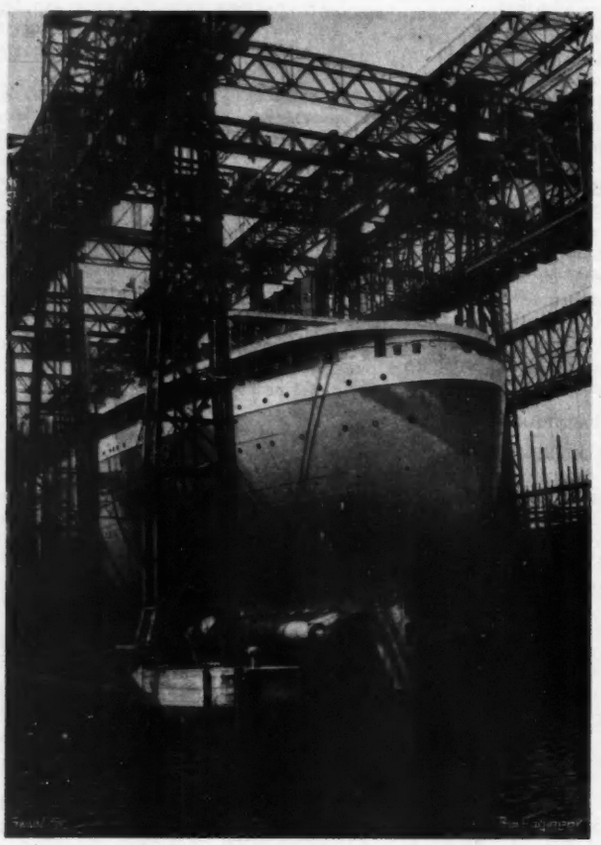
The Chuquicamata mine, situated about 10,000ft above sea level, is connected by a railway about 147 miles long with Antofagasta and by a motor road with Tocopilla. The climate is arid and healthy, but the great problem is water supply; requirements are met by three pipe lines, one 55 miles long, the other two each 36 miles long. The workings are all above ground.

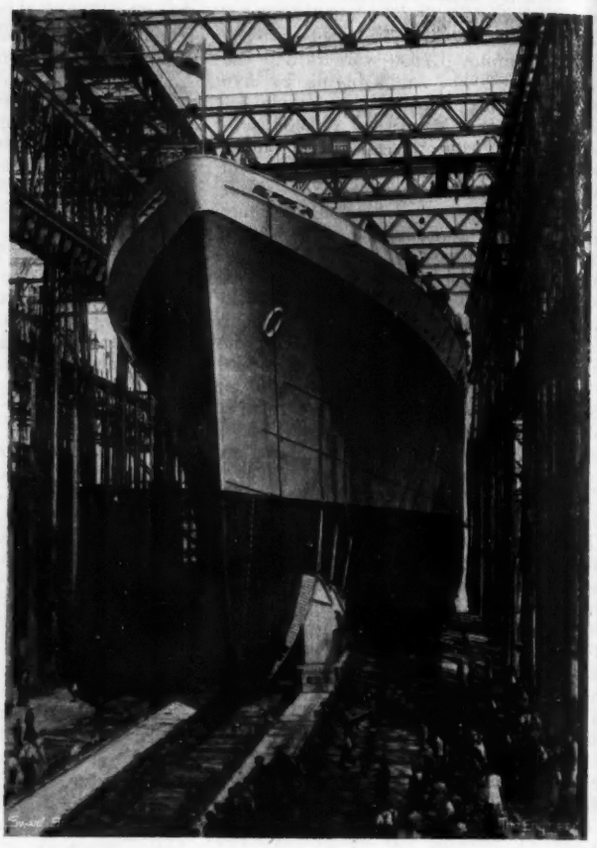
The Braden property has been worked

† "Chile's Copper Industry," by L. H. Tarring, joint editor of the Metal Information Bureau, Ltd., writing in *The Latin-American World* for January, 1945.

LAUNCH OF R.M.S. "PRETORIA CASTLE"

HARLAND AND WOLFF LTD., BELFAST, BUILDERS





since the beginning of the eighteenth century, American participation dating from 1904. Work was first started in the Potrerillos mine of the Andes Copper Company in 1916, where the ore is mainly oxide. The quantity of ore treated and copper produced at these three mines, compiled from figures issued by the United States Bureau of Mines, in 1939, are as follows :—

	Ore treated.		Copper production.	
	Tons.	Per cent copper.	Tons.	Per cent
Chuquicamata ...	9,808,564	1·71	102,513	99·96
Potrerillos	4,515,300	1·46	55,485	99·61
El Teniente ...	6,319,254	2·15	118,762	99·65

Chile's capacity for producing fine copper at the end of 1941 was given as 480,000 tons a year, a figure which has increased subsequently.

An interesting and significant development has been the participation of the Corporacción de Fomento de la Producción in a new company formed with the object of manufacturing copper wire and sheets in Chile. The annual output of wire is given as 30,000 tons and Chilean producers have been informed that they must look overseas for their markets. Prior to the war, the greater part of the copper produced in Chile went to Europe.

When the United States entered into the war, her demands for copper increased tremendously, so that she absorbed the entire production of Chile and encouraged increased production there. The United States has been drawing upwards of 500,000 tons of copper a year from Chile, or more than a quarter of her consumption of new metal.

(To be continued)

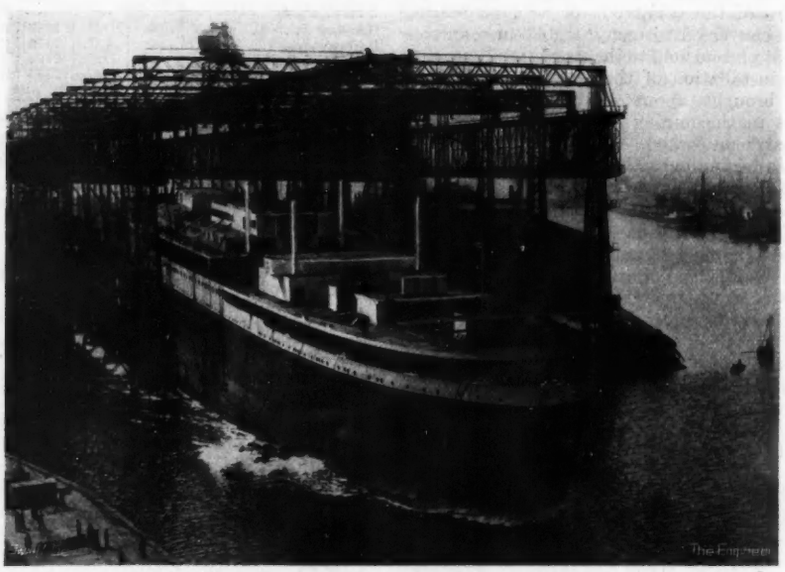
Launch of R.M.S. "Pretoria Castle"

ACCOMPANYING engravings illustrate the launch, on August 19th, of the new Union Castle liner "Pretoria Castle." This ship, which is being built by Harland and Wolff, Ltd., at Belfast, will be used on the South African mail service of the Union Castle line.

The "Pretoria Castle" is the largest merchant ship to be launched since the war, and also the largest which her builders have constructed for the Union Castle Line. The vessel is designed on modern lines with a curved stem, cruiser stern, two masts and a single funnel. Her principal dimensions are :

Length, overall	About 750ft.
Breadth, moulded	83ft 6in
Gross tonnage	About 28,500

There are seven holds, suitably arranged to carry general and refrigerated cargo. The spaces allocated for refrigerated cargo have temperature regulation by brine-cooled batteries with air circulation. Accommodation is designed for about 250 first-class passengers in single and two-berth rooms, a large proportion of the rooms having private bathrooms. There are to be two special suites, each consisting of



"PRETORIA CASTLE" LEAVING THE WAYS

bedroom, sitting-room, bathroom, &c., and eight cabins de luxe. Cabin class accommodation will be available for about 500 passengers in two-berth, three-berth, and a few four-berth cabins.

The propelling machinery consists of Parsons turbines, driving two screw shafts through gearing, steam being supplied by three Babcock and Wilcox water-tube boilers. Electric power is supplied by three turbo-generators whilst the vessel is at sea; for port use two diesel generators are fitted. The navigation equipment will include a radar installation. We hope to be able to give more complete details of the ship on her completion.

The ship was launched by Mrs. Smuts, wife of the Prime Minister of South Africa, from her home near Pretoria, by the use of radio-telephony. After naming the ship Mrs. Smuts pressed a button. That action, by transmitting a radio impulse, amplified upon receipt, set the ship in motion down the ways.

The Royal Netherlands Industries Fair

THE Royal Netherlands Industries Autumn Fair is to be held at Utrecht from September 9th to 18th and will occupy two sites, known as the Croeselaan site and Vredenburg Square. The first of these sites will be occupied by the technical sections of the Fair, including engineering, hardware, tools and metals; transport and traffic; industrial applications of electricity; lighting, heating and sanitary engineering for industrial purposes; and dairy machinery. On the Vredenburg Square site will be found exhibits demonstrating the domestic applications of electricity; domestic lighting, heating and sanitary equipment; textiles; and chemical and allied products. A special department has been set up by the organisers of the Fair for the purpose of providing foreign buyers with any information which they may need, and the first two days are to be reserved specially for foreign visitors. We may say that THE ENGINEER will be exhibited on Stands No. 2549/57 in the main Vredenburg building and No. 21 in the Croeselaan building, and that visitors will be welcomed.

Retirement of Mr. J. C. Martin from London Transport

WITH the retirement of Mr. James Cecil Martin on August 20th, the chief engineer's department of the London Passenger Transport Board has lost the services of an engineer who has given the greater part of his life to the design and construction of London's tube railways. Mr. Martin's career began with his apprenticeship to the civil engineering department of the old Great Northern Railway at King's Cross. A brief spell in the Argentine as assistant engineer with the Buenos Aires and Pacific Railway was followed by his appointment as chief assistant to the late Sir Harley H. Dalrymple-Hay on the construction of the Bakerloo, Hampstead and Piccadilly "tubes" in 1903–7, the first escalator in England at Earl's Court in 1911, the Hendon to Edgware Extension of the Northern Line during 1923–4, its connection to the Northern City Lines at Camden and Kennington in 1924–6, and the extension of the Piccadilly Line from Finsbury Park to Southgate in 1932–3. During the past twelve years, Mr. Martin has prepared schemes for London Transport's 1935–40 new works programme which was suspended during the war, resulting in various improvements to the Metropolitan Line such as the construction of flying junctions at Neasden and Stanmore, new stations at King's Cross and Uxbridge, and the underpinning of Finchley Road Station. This programme also included, amongst other work, new rolling stock depots at Grange Hill and Elstree and new stations at Edgware, Wood Lane and Sloane Square. During his service Mr. Martin designed every station and supervised the sinking of every shaft for the Post Office (London Railway) Tube, and he was charged with London Transport's interests in the construction of the eight Home Office deep-level shelters built to "tube railway" pattern in 1940–3. He designed the deep-level shelter for the London, Midland and Scottish Railway at Euston in 1940, and devised schemes for urgent protective works in connection with underground railways prior to the erection of permanent floodgates during the war. For the London County Council he designed the Deptford Creek bascule bridge in 1910. As an authority on tube railway construction Mr. Martin's advice has frequently been sought by outside concerns, and in 1932 he was a member of the Commission which went to Moscow at the invitation of the Soviet Government to advise them on the construction of the Moscow Underground. Mr. Martin, who is a member of the Institution of Civil Engineers, and a Fellow of the Permanent Way Institute, served as a Major in the Royal Engineers in the 1914–18 War, and was decorated with the Order of the British Empire for services rendered as Chief Engineer of the National Shipyards in the Bristol area.

A Sleeper Tamping Machine on the L.N.E.R.

THE accompanying photograph shows a "Matisa" (Scheuchzer) automatic tamping machine for ramming ballast under sleepers which is undergoing trials by the chief engineer's department of the London and North-Eastern Railway Company.

The machine comprises a chassis mounted on rail wheels and carrying the motor and mechanism which operates sixteen tamping tools. The machine is designed to travel along the line under its own power at a speed of some 25 miles an hour. It can be moved from the line by two men in a few minutes on to a pre-sited parking platform. When in use only one operator is required to drive and control the machine.

AUTOMATIC TAMPING MACHINE FOR SLEEPERS

The sixteen tamping tools projecting downwards from the chassis are arranged in pairs, one tool being set on each side of the sleeper. When the machine is in operation these tools are mechanically vibrated and penetrate vertically into the ballast on either side of the sleeper. At the set depth of penetration each pair of tools, still vibrating, is drawn inwards in a horizontal direction to compress the ballast into a compact mass beneath the sleeper. When this compression has reached a preset maximum the tools are automatically released. When the tamping of a sleeper is completed the tools are withdrawn and the machine is moved under its own power to the next sleeper. Usually one penetration of the tamping tools is sufficient, but, if the track has been given a lift of more than 2in, a second tamping operation is required.

On an average the machine takes about fifteen seconds to tamp a sleeper and is stated to produce uniform and well-consolidated results. It is not necessary to open the ballast when repairing track with this machine, and its use saves much time and shovel work. The company states that it believes that the machine may enable the period which traffic requires to travel at slow speed after permanent way renewals to be reduced.

World Fuel Economy Conference

THE Fuel Economy Conference which is being organised by the World Power Conference begins at The Hague, Holland, on Tuesday next, September 2nd, and will continue until Wednesday, September 10th. The total British delegation will number over one hundred and will be headed by Sir Johnstone Wright, Chairman of the Central Electricity Board. Sir Ernest Smith is to act as Chairman of a special session to discuss the collective reports on fuel economy since 1939; Mr. J. Eccles, President of the Incorporated Municipal Electrical Association, will be Chairman of the section entitled "Production: Electric Energy," and Professor Douglas Hay, Chief Mining Engineer of the National Coal Board, is the first Vice-Chairman of the section dealing with "Production: General." The Ministry of Fuel and Power, the Admiralty, the Air Ministry, the Department of Scientific and Industrial Research, and the Ministry of Supply will all be represented at the conference. Amongst the papers to be presented by the British National Committee, the following may be mentioned:—"The British Coal Survey as a Factor in Fuel Economy," by Dr. A. Parker and Mr. A. C. Maries; "Development in Coal-Mining Mechanisation in Great Britain," by Professor Douglas Hay; "Aviation Fuel Production," by Mr. J. A. Oriel and Major K. Gordon; "Fuel Economy in Coal Carbonisation," by Mr. T. C. Finlayson; "The Co-ordination of Electricity Supply," by Sir Johnstone Wright; "The Possibility of Industrial Applications of Atomic Energy," by Dr. J. D. Cockcroft; "The Functions of Convection and Radiation in Heating by Gas," by Dr. A. L. Roberts and Mr. L. W. Andrew; "The Availability of Power Station Boilers," by Dr. H. E. Crossley; "Dependence of Gas Turbine Economy on Internal Aerodynamic Design," by Dr. H. Roxbee Cox, Mr. A. R. Howell and Mr. A. G. Smith; and "The Recovery of Industrial Low-Grade Heat," by Dr. W. A. Macfarlane and Mr. J. B. M. Meson.

Metallurgical Topics

Grain Boundaries in Metals

At least thirty-five years ago Rosenhain[1] suggested that the grain boundaries in metals might be regarded as consisting of an amorphous intercrystalline cement. This assumption was based primarily on the fact that the grain boundaries in a metal behaved as regions of high strength at low temperatures and high rates of deformation, and as regions of weakness at high temperatures and low rates of deformation. This is precisely the behaviour of amorphous or viscous materials. The evidence put forward by Rosenhain[2] and later by Jeffries and Archer[3] showed clearly that the grain boundaries behaved as if they were amorphous, but probably no metallographic subject has caused more controversy than the nature of the grain boundary. Metallurgists

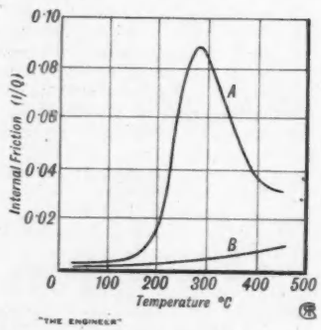


Fig. 1—*Variation of Internal Friction with Temperature in (A) Polycrystalline and (B) Single Crystal Aluminium (Frequency of Vibration, 0·8 Cycles Per Second at Room Temperature)*

were reluctant to accept the concept of an amorphous phase. It was more generally held that there was merely a transition layer at the grain boundary where the atom positions represent a compromise between the crystalline arrangement of two adjoining grains, or possibly such a layer in which minute crystallites were embedded.

More important than any of these hypotheses, however, is the question as to whether the grain boundary does, or does not, behave in a viscous manner with a coefficient of viscosity which decreases with an increase of temperature. A summary of much of the evidence for the viscous behaviour of the grain boundary has

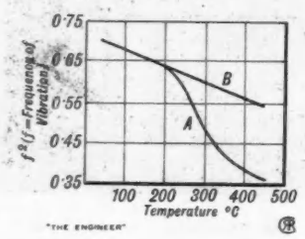


Fig. 2—*Variation of Rigidity with Temperature in (A) Polycrystalline and (B) Single Crystal Aluminium*

been prepared by Professor C. Zener,[4] of the University of Chicago. Professor Zener and his co-workers[5] have made a preliminary study of the viscous behaviour of the grain boundaries of zinc, α-brass and α-iron by measurements of internal friction and elastic after-effect. In a paper entitled "Experimental Evidence of Viscous Behaviour of Grain Boundaries in Metals," another of Professor Zener's collaborators, T'ing-Sui Kê,[6] has thoroughly examined the mechanical behaviour of the grain boundaries of aluminium (and to a lesser degree of magnesium) by quantitative measurements of four anelastic effects. An anelastic effect is one in which stress and strain are not uniquely related within the elastic range as defined by absence of permanent set. Absence of permanent set does not imply perfect elasticity in the sense of a linear relationship between stress and strain.

A simple torsional apparatus was devised for measuring four types of anelastic effects at

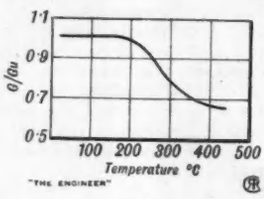


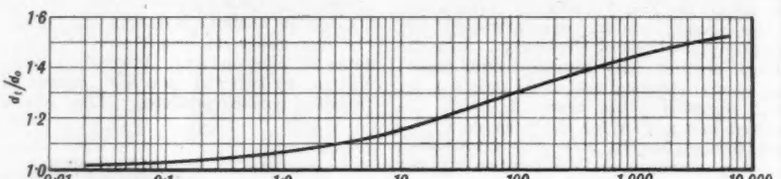
Fig. 3—*Relaxation of Rigidity in Polycrystalline Aluminium*

low stress levels, viz., internal friction at low frequencies, variation of dynamic rigidity with temperature, creep at constant stress and stress relaxation at constant strain. All four effects were studied in both polycrystalline and single crystal aluminium of 99·991 per cent purity. All four types of effect were completely recoverable, *i.e.*, involved no final permanent set, and were linear with respect to the applied stress and prior strain. The results are shown in Figs. 1 to 5. For individual values, which fall very closely on the curves shown, the original paper should be consulted.

Variation in internal friction with temperature of measurement is shown in Fig. 1. It reached a maximum at 285 deg. Cent. in the polycrystalline material. The internal friction of the single-crystal aluminium increased slightly with temperature of measurement, but there was no maximum. The aluminium used had been drawn from 0·15in diameter rod, annealed at 500 deg. Cent., down to 0·033in diameter wire (95 per cent reduction of area) and then annealed at 450 deg. Cent. for five hours. It then consisted of uniform grains of average grain diameter 0·03cm. The single-crystal material did not contain more than a few crystals per 12in length of wire.

Fig. 2 shows the variation of rigidity with temperature. The rapid change at 200 deg. Cent. was not observed in single-crystal aluminium which gave a straight line relationship. The rigidity of the single-crystal aluminium can be regarded as the unrelaxed rigidity, G_U. The relaxation of rigidity at temperature t is expressed by G/G_U. These ratios for different temperatures, when plotted, give the curve in Fig. 3, the value remaining at about 1·0 deg. up to 200 deg. Cent., and then falling over a range of temperature to 0·67 when relaxation is apparently complete. If G_R is the relaxed rigidity, $G_R/G_U = 0·67$. From strain energy considerations Zener arrived at the conclusion that for equiaxial grains when relaxation of shearing stress across the grain boundaries is complete, $G_R/G_U = 0·636$, which is in good agreement with the value 0·67 shown by Fig. 3.

To investigate creep the wire was treated as the suspension of a moving coil galvanometer. The maximum deflection employed was 8cm on a scale 3m away, corresponding to a shear strain on the surface of the wire of 2×10^{-5}, and the creep was measured by the ratio d_t/d_o, where d_o is the instantaneous deflection and d_t the deflection after a time t. Fig. 4 is a composite curve of creep at different temperatures reduced to 200 deg. Cent. Creep

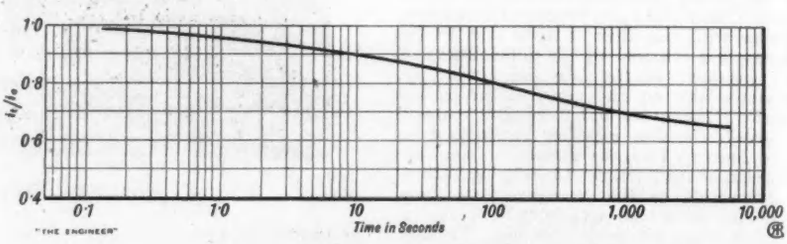


Temperature of Measurement			
150 Cent.	Time ÷ 71	225 Cent.	Time × 6·1
175 Cent.	Time ÷ 7·5	250 Cent.	Time × 31
200 Cent.	—	Heat of activation	34,000 cal/mol

Fig. 4—*Composite Curve of Creep Under Stress at 200 deg.Cent. in Polycrystalline Aluminium*

is a function of $t \cdot e^{-H/RT}$ and 4·6 (*i.e.*, 2·3*R*) times the slope of log t plotted against 1/*T* gives H, the heat of activation associated with the viscous slip.

Fig. 5 is a composite curve of stress relaxation at constant strain. The torque on the galvanometer suspension is proportional to the current, and the current required to keep the deflection constant at 4cm was measured at different temperatures. The stress required to maintain



Temperature of Measurement			
150 Cent.	Time ÷ 74	225 Cent.	Time × 6·2
175 Cent.	Time ÷ 7·7	Heat of activation	34,500 cal/mol
200 Cent.	—		

Fig. 5—*Composite Curve of Stress Relaxation at Constant Strain at 200 deg. Cent. in Polycrystalline Aluminium*

constant strain after a time t in terms of the original stress is given by i_t/i_o. Stress relaxation was almost complete in one hour at 225 deg. Cent., giving an asymptotic value of 0·67. The heat of activation associated with the observed stress relaxation gave a value (34,500 cal/mol) almost identical with that derived from creep. From this, the estimated coefficient of viscosity at 670 deg. Cent. was 0·14 poise, while the value reported to have

been found at that temperature is 0·065 poise.

No appreciable creep and no appreciable stress relaxation occurred with single crystal aluminium.

The results were consistent, within experimental error, with the inter-relations derived by Zener[4] implying that a common source of anelasticity lies in the relaxation of shear stress across localised areas that behave in a viscous manner with respect to shear stresses, and that are embedded in an elastic matrix. All these effects are therefore consistent with the viewpoint that the grain boundaries behave in a viscous manner. The maximum amount of shear stress relaxation in polycrystalline aluminium determined by the four types of anelastic measurement was about 33 per cent, which was in good agreement with the value 35 per cent calculated by assuming the grain boundary to be viscous. The coefficient of viscosity at 670 deg. Cent. estimated from the heat of activation associated with the viscous slip observed in these tests was of the same order as that reported to have been found for liquid aluminium at the same temperature.

These experimental data, combined with confirmatory results on magnesium and previous work on other metals and alloys, indicate that, whatever may be the nature of the intergranular region, viscous behaviour of the grain boundaries is a characteristic common to all metals.

[1] W. Rosenhain and D. Ewen: "Intercrystalline Cohesion in Metals," *Journal*, Inst. Metals, 1912, Vol. 8, page 149.
[2] W. Rosenhain: "Introduction to Physical Metallurgy" (Constable), 1915, pages 255 to 264; also May Lecture, Institute of Metals, 1923 (2).
[3] Z. Jeffries and R. Archer: "The Science of Metals" (Mc-Graw-Hill), 1924, Chapter 4.
[4] C. Zener: "Anelasticity of Metals," American Institute of Mining and Metallurgical Engineers, Technical Publication No. 1992; *Metals Technology*, August, 1946.
[5] See references in Zener[4], also W. A. West: "Elastic After-Effects in Iron Wires from 20 deg. to 550 deg. Cent.," *Metals Technology*, August, 1946.
[6] T'ing-Sui Kê: *Physical Review*, 1947, Vol. 71, page 533.

The Notched-Bar Impact Test-Piece

AGREEMENT as to the most suitable form of notched-bar test piece for international standardisation is likely to remain as remote as ever since there is no general satisfaction with the test pieces which have already been standardised for use in different countries.

Reference may be made to two recent publications: one raising what the author regards

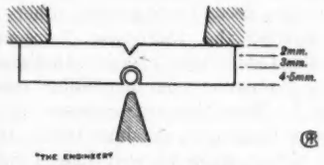


FIG. 1—*Schnadt Test Piece*

as a fundamental objection to the distribution of stress and deformation in the usual form of test piece, and the other summing up rather strongly against a very common form of notch.

PROPOSED NEW FORM OF TEST PIECE

As everyone realises, the compression stresses set up on the side of the test piece opposite the notch give rise (unless brittle fracture rapidly occurs) to a region in which the metal has suffered deformation in compression and has absorbed a substantial amount of energy in the process. The minimising of this effect by notching both sides of the specimen has been suggested, and arguments have been put forward on these grounds in favour of notched tensile rather than notched bend tests; but the proposal now made by Schnadt, quoted by J. A. Haringx,[1] is to remove the material in the region which would become the compression zone by drilling a hole, 5mm in diameter, in the specimen and inserting a loose-fitting hardened steel pin. During bending the centre line of the pin acts as a pivot so that the material of the test piece in the path of the fracture is subjected exclusively to tensile stress. The pendulum strikes against the hardened steel pin instead of against the softer material of the test piece (Fig. 1). It is not clear how the pin is kept in position when the notch is vertical, as in the Charpy machine—presumably by an enlarged end—but that difficulty would not arise with the Izod machine. Different forms of specimen are advocated: one with a sharp notch, 1mm deep, indented by a knife edge (depth of test piece 8·5mm), and another unnotched (depth of test piece 7·5mm), the former being for use only for material which is intended to withstand specially high stress concentration.

These proposals appear to introduce an unnecessary complication into the impact test. It has long been recognised that "work done to fracture" is an indication of merit, not a figure of merit; and the results obtained with the proposed test piece are unlikely to give (as was intended) a more "reliable measure of the tendency of the material investigated towards brittle fracture" than the usual test. The region of compressional deformation which it is sought to avoid is non-existent or at least very small in test pieces of brittle materials, and though it adds to the energy absorbed by materials which offer appreciable resistance to fracture, its effect is to emphasise the distinction between the tough and brittle conditions.

COMPARISON OF FORMS OF NOTCH

A careful study has been made by N. A. Kahn and E. A. Imbembo[2] of the reproducibility of results obtained in the single-blow Charpy notched-bar test with the 45 deg. V notch, 2mm deep, root radius 0·25mm (British Standard V notch) and the Charpy keyhole notch, 1mm radius, 5mm deep, opened up by a saw cut. The authors had the assistance of seven industrial and Government laboratories in carrying out the comparative tests, which were made on a uniform, stress-relieved, low-carbon, semi-killed steel having the composition:—

	Per cent.
Carbon	0·22
Silicon	0·17
Manganese	0·51
Sulphur	0·040
Phosphorus	0·015

Charpy test blanks of this steel, machined but not notched, were sent to the seven laboratories. Each laboratory produced twelve keyhole and twelve V notch specimens, six of each being tested in the laboratory and six returned to the authors for testing at the New York Naval Shipyard.

The evidence, in the authors' opinion, indicated a definite superiority of the keyhole over the V notch for the class of steel investigated, and how strong that evidence was may be judged from the brief summary of results in Table I.

TABLE I.—*Spread of Results (in Foot-Pounds) with Different Forms of Notch (Kahn and Imbembo)*

	Keyhole notch.		V notch.	
	Notched by co-operators, tested by authors.	Notched and tested by co-operators.	Notched by co-operators, tested by authors.	Notched and tested by co-operators.
Overall spread of individual results	31·7 to 44·5=12·8	28·5 to 41·8=13·3	17·1 to 49·2=32·1	14·2 to 60·2=46·0
Spread of averages	34·3 to 38·8= 4·5	30·7 to 39·4= 8·7	18·9 to 41·4=22·5	15·9 to 55·9=40·0
Overall average	35·6	34·1	30·9	33·7

Further evidence in favour of the keyhole notch was disclosed by tests carried out by the authors over a range of temperature. The transitional region, in which fracture may be either fibrous or granular, was more restricted with the keyhole notch than with the V notch, and the values of energy absorbed, though in both cases scattered, tended with the keyhole notch to fall on the upper and lower curves and not at intermediate positions (Fig. 2).

In explanation of the superior indication Kahn and Imbembo refer to the difficulty of reproducing the exact contour and finish of the root radius of the V notch in comparison with the precision with which the keyhole notch can be drilled. Though their photographs show that there were differences between the notches produced by different laboratories, it seemed unlikely that these differences would in themselves account for the wide divergence of the results, so an explanation of the greater

TABLE II.—*Spread of Results in the Transition Zone (Kahn and Imbembo)*

	Keyhole notch.	V notch.
Temperature of transition zone, deg. Fah.	40–0	100–60
Temperature of test:		
Above zone, deg. ...	50	120
Spread of results, ft-lb	31·5 to 34·5	77·3 to 90
Below zone, deg. ...	−20	40
Spread of results, ft-lb	2·5 to 3·0	16·0 to 20·0
Middle of zone, deg. ...	20	80
Spread of results, ft-lb	6·5 to 30·3	31·5 to 61

scatter with the V notch was sought in the temperature-impact relationship. Attention was directed to the statement of McAdam and Clyne, based on the work of Greaves and Jones, that "the sharper the notch the higher the temperature of drop," referring to the effect of the notch on the temperature of transition

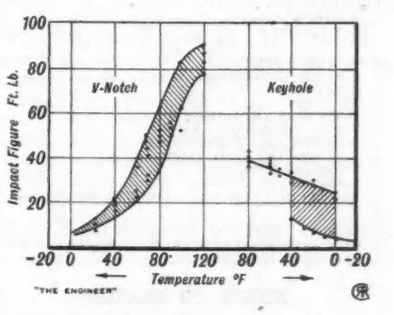


FIG. 2—*Impact Figure—Temperature Relationship for V Notch and Keyhole Notch*

from fibrous to granular fracture. The temperature of 70 deg. Fah. which had been adopted for the comparative tests was within the transition zone for the V notch specimens. That, in itself, might result in scatter which would be intensified by the effect of slight differences in the contour of the notch, as well as in the actual temperature of test.

When full consideration is given to this report it seems that the keyhole notch was rather strongly favoured by circumstances in the comparative test, and that further comparison with, for example, heat-treated alloy steels should be made before a decision is reached. It would not be surprising to find that the spread of results was quite normal outside the transition zone of temperature. Nor should it be overlooked that the V notch has the greater sensitivity, giving greater differences between tough and brittle material, and as a minor point is easier to machine when large numbers of test pieces are required.

[1] J. A. Haringx: *Engineers' Digest*, March, 1947, page 77; from *De Ingenieur*, December 13, 1946, Vol. 58, page 15.
[2] N. A. Kahn and E. A. Imbembo: *A.S.T.M. Bulletin*, May, 1947, page 66.

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"CONVERTIBILITY" AND COAL

HOWEVER much the Government's economic advisers may seek to justify the optimism that ruled amongst them to the very last about the consequences of making current sterling convertible into dollars, the history of the last few weeks can be very simply written down. A dollar-starved world found in "convertibility" a Heaven-sent opportunity to gather dollars. For the export of goods to Britain became a simple means of paying for goods bought from America. Britain's excess of imports over exports was, in fact, used to pay for American exports to the world at large. Such a condition could not persist indefinitely. On Wednesday of last week, Mr. Dalton had to announce that the pound sterling was no longer freely convertible into dollars. As an immediate consequence what little remained of the American loan was "frozen."

What will be the effect upon our economy of that sudden *volte-face* remains to be discovered. Much, obviously, depends upon the attitudes adopted by the countries with which we trade and more particularly by those with which "convertibility" agreements had been drawn up. On the one hand, the fact that sterling is now no longer convertible should eliminate the advantage found by certain countries in imposing restrictions upon imports from the sterling areas with the object of building up sterling balances for conversion into dollars. On the other hand, though still freely usable within the sterling areas sterling is obviously less valuable now in a dollar-starved world than it was when convertible into dollars. It is therefore possible that some countries may prove less willing than before to send their exports to Britain unless payment is made in dollars. Such an attitude if adopted would be unlikely to change until such time as Britain's exporting capacity equalled its import demand, thereby restoring to sterling its full power of buying British exports. But, whatever the reaction of overseas markets to Mr. Dalton's statement, the virtual sudden exhaustion of the dollar loan months ahead of the date originally contemplated and weeks ahead even of the date predicted in Parliament's recent debate on "the state of the nation" makes the programme announced by the Government in that debate seem even less adequate than ever. For the need to balance our overseas trading at a very early date has become more than ever urgent. It is no longer possible to remain so confident that the future development of home agriculture with the object of reducing our dependence upon imports of food, or the future building up of our industrial capacity with the object of increasing exports can now be achieved in time to prevent the expenditure of our last reserves of dollars. The whole organisation of our overseas trade must come under review, our imports must be severely pruned, and in consequence our standard of living must temporarily fall.

The main lines of the policy that the Government must now hope to pursue are clearly visible. It is, too, certain that engineers will be closely concerned in putting that policy into effect. They will be called upon to increase the productivity of the country's engineering factories; they will be responsible for producing that mass of agricultural machinery without which the Government's plans for the expansion of home food production would come to nought; and they will, too, be asked to manufacture the industrial machinery for many trades by the use of which the output of our limited manpower can be multiplied. But as we have repeatedly emphasised ever since the war ended, machinery has no value unless there are available ample supplies of power and fuel to keep it in operation. If the two sides of other industries, following the example of the engineering employers and unions, can hasten agreement upon staggered hours of work and rates of pay; and if means can be found so to adjust contract supply conditions that power-using firms are encouraged towards rather than dissuaded from taking individual action to reduce their peak demands, the staggering of hours of work should permit substantially more power to be generated this winter than last without exceeding the peak capacity of the generating plant available. But no such adjustment of demand to supply can be applied to coal. Only a greater output from the mines can alleviate the winter coal scarcity that threatens. Without more coal the planned steel ingot production of 14 million tons can never be reached, power stations will be unable to provide that increased generation that staggering of working hours is designed to permit, industry will be unable to produce to the limit of its steadily increasing capacity, and engineers will find it useless to make that machinery which, by economising human labour, can break the manpower shortage. It is true that to-day distributed stocks of coal stand at a level some 4 million tons higher than a year ago. But in relation to the improved rate at which industry hopes to be producing during the winter months that level still seems dangerously low. Moreover, coal production this year is already some millions of tons behind schedule if the target of 200 million tons in 1947 is to be realised. That limited target, too, was set up at a time when it was still assumed that the support of the American loan would last well into 1948 at least. Lord Hyndley, addressing the Coal Board's summer school at Cambridge last Tuesday, referred to the Board's great plans for reorganising and re-equipping the pits. But the influence of that work upon output cannot be felt under a term of years whereas the need for increased supplies of coal is immediate. It is to be hoped therefore that the miners' union will rapidly reach agreement with the Board upon the working of longer hours and that the miners themselves will abide by the spirit of the terms of that agreement. For the raising of the productivity of the coal mines is the key to the successful emergence of this country from its economic troubles.

MATTERS OF URGENCY

THE people of this country are often reminded by Government and other spokesmen and by the Press that they are living in a time of extreme urgency. It is, however, difficult to escape the feeling that whilst many folk are aware that there is something wrong that needs putting right, others seem to overlook the fact that "urgent"—according to the Oxford English Dictionary—means "pressing, or demanding prompt action." This time of extreme urgency has now been upon us since 1939. In the years of war, when we were indeed fighting for our lives, there were plenty of examples that this nation was well able to take prompt action when necessary. Engineers in particular provided many such examples; urgent requirements in the way of war materials were readily forthcoming; public services were quickly restored after damage by bombing; mighty works such as Mulberry, Pluto and Fido were designed and completed with speed and determination; and new plant and unusual arrangements regarding hours of working were devised and put into operation in the shortest possible time. In fact, whenever and whatever matters became urgent, the people of this land, following their best traditions, proved themselves ready to show that first things were first and to take prompt action.

In the two years which have elapsed since the end of the war, the nation has discovered that peace has its perils, and that its economic recovery now seems likely to be a slow and painful process. It has to be admitted, however, that there are indications that, as a

people, we appear to be less ready now to take prompt and useful action about the urgent needs of industry and the national economy generally. One recent example supporting this assertion is conveyed by an official statement issued a fortnight ago after a meeting of the Minister of Labour's Joint Consultative Committee. It was reported to the Committee—which consists of representatives of the British Employers' Confederation and the Trades Union Congress—that there would be difficulty in putting into operation by October 1st schemes for staggering working hours to spread the electricity load unless the necessary arrangements were made in good time. Both sides of the Committee agreed in "stressing the urgency of settling those questions," and commented further that unless the arrangements were made speedily, there would be a danger of load-shedding. It may be that this year's fair summer weather has helped to dispel the bitter recollections of last winter's severity and of the dislocation caused by load-shedding, but, nevertheless, it is surely essential that arrangements should be completed for averting a recurrence of the disaster with which industry was faced in the early months of the year. The engineering industry, let it not be forgotten, has made an agreement over terms and conditions for staggering hours of work, an agreement which the British Employers' Confederation and the T.U.C. declare to be a satisfactory model for other industries to follow. Obviously, however, if the staggering of hours is to be effective in spreading the power load, the co-ordinated effort of all industries is essential.

Several months have passed since it was first suggested that working hours should be staggered in order to lessen the likelihood of load-shedding next winter. As indicated in these columns last week, the Electricity Commissioners, in conjunction with the Ministry of Fuel and Power, have recommended a scheme, operating from October, whereby each electricity undertaking will have a target maximum demand to which its load must be reduced at the request of the Central Electricity Board. The Regional Boards for Industry, without doubt, are busy giving consideration to various suggestions for staggering working hours in the most convenient and useful manner possible, though it has been suggested that no announcement of the plans to be adopted can be expected for another week or two. If the schemes for staggering are to be operated from early October, agreement throughout industry over conditions of working becomes a matter of considerable urgency, and one which will require to be settled speedily. This is but one matter in which delay in reaching a decision may be dangerous. The present state of our national economy will unquestionably continue to provide a number of difficult problems for industry to solve—in particular problems relating to fuel, raw materials, manpower and hours of work—and all of them problems which will call forth all our ingenuity and resourcefulness. It is to be earnestly hoped that the renewed efforts which every section of industry is being called upon to make will not be thwarted by those who do not yet appear to understand that urgent matters demand prompt action.

Obituary

WALTER POLLOCK

THE marine engineering profession has been deprived of one of its prominent members by the death of Mr. Walter Pollock, which occurred after a long illness at his home at Tunbridge Wells on Friday last, August 22nd. He was born in 1873 and was the son of Mr. James Pollock, who founded the shipbuilding and marine engineering firm of James Pollock, Sons and Co., Ltd. In 1910, Walter Pollock succeeded to the chairmanship of the firm, and it is said that he was personally responsible during his career for the design and construction of some 3000 vessels of varying types. In 1917, he founded the firm's Faversham shipyard at the request of the late Lord Fisher, who was then First Sea Lord. During the 1914–18 war, Mr. Pollock designed and had constructed under his jurisdiction, in co-operation with Lord Fisher, numerous "X" lighters which were the forerunners of the tank landing craft employed in the recent World War.

Mr. Pollock was a member of the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Institute of Marine Engineers, to the proceedings of which societies he contributed several papers. He was also very well known for his activities in the London Livery Companies, being a Past-Master of the Worshipful Company of Plasterers, and a member of the Court of Assistants of the Worshipful Company of Shipwrights. In this last office he served as chairman of the committee which was responsible for the organisation of the Shipwrights Exhibition held in London in the early part of this year. In addition, Mr. Pollock was the author of a number of books on the design and construction of small vessels.

ROY CHADWICK

WE regret to have to record the death in a flying accident of Mr. Roy Chadwick, one of Britain's foremost aircraft designers, and technical director of A. V. Roe and Co., Ltd. A report of the accident is printed elsewhere in these columns.

Roy Chadwick was born fifty-four years ago at Farnworth, near Bolton, and was keenly interested in aviation at an early age, designing and building model aircraft. For more than thirty-five years he was chief designer to A. V. Roe and Co., Ltd., and during that time he was concerned with the design of more than thirty Avro aircraft, including the famous Avro "504" training machine of the 1914–18 war. In the recent war, the "Anson," "Manchester" and "Lancaster" were all products of his genius. During the earlier years the Avro "Anson," a bomber and reconnaissance machine, was widely flown by R.A.F. Coastal Command, and the "Manchester," a large twin-engined bomber, on a smaller scale. From the latter Chadwick evolved the famous "Lancaster" four-engined bomber, which was so extensively used in night bombing attacks on Germany. It was possibly the most successful bomber of the war, and was the only one which could carry a 10-ton bomb. Chadwick then designed the "Lincoln," now the standard R.A.F. bomber, intended for the assault on Japan which did not materialise.

With the end of the war Mr. Chadwick turned to the design of interim and other types of civil aircraft, producing the "York," "Lancastrian" and Avro "XIX," and finally the "Tudor" range of aircraft, developed for our overseas airlines. At the time of his death he was working on the design of an advanced airliner to be fitted with gas turbines.

He was made C.B.E. in 1943, was a Fellow of the Royal Society of Arts and a Fellow of the Royal Aeronautical Society. Earlier this year he became technical director of A. V. Roe and Co., Ltd., giving up his post of chief designer to Mr. S. D. Davies, who was injured in the accident in which Mr. Chadwick was killed.

Roy Chadwick had a natural flair for aircraft engineering, and devoted his whole life to it. He combined this quality with a quiet manner, good humour, and a friendly nature, pleasing to all. His death at a time when the country is greatly in need of first-rate aircraft designers is a serious loss.

Literature

SHORT NOTICES

The Amateur's Workshop. By Ian Bradley. London: Percival Marshall and Co., Ltd. 1947. Price 7s. 6d.—Although there is much general matter in this volume it might almost be called "*An* Amateur's Workshop" and a guide to a very popular amateur lathe—the Myford or Myford-Drummond. It is to this lathe and its accessories, either purchased or home-made, that the author devotes his principal attentions, but there is a lot of talk, most of it very sound, about other matters. We would commend particularly Mr. Bradley's remarks on drills and drilling and his arguments in support of the straight-fluted drill. We do not know what the author's workshop "hobby" is, but from internal evidence we are led to suspect that it is either tool making or small engineering rather than model making. His workshop is undoubtedly well equipped, and an excellent chapter on "Improving the Scope of the Inexpensive Lathe," which includes clear designs for such details as indexes, dividing gear, lever feed for tailstock, high-speed drilling spindle, and so on, indicates that he has made much of the equipment himself. A concluding chapter gives all the necessary instructions for the making of a small draughting machine of the pantograph type.

Industrial High-Voltage Distribution. By E. J. Barrows, A.M.I.E.E. London: Sir Isaac Pitman and Sons, Ltd. 15s. net.—This book aims to provide works engineers and others who may be interested with a knowledge of certain aspects of a.c. distribution that will help them to assess short circuit current values from normally available system data—a problem of growing importance with the rapid increase in the size of modern supply systems. The author introduces his subject by outlining the development of industrial a.c. supplies, leading up to the calculation of impedance and short circuit values, the use of current-limiting reactors, and the choice of plant of suitable capacity. These principles are illustrated by several specimen lay-outs, showing transmission from power stations and various methods of effecting internal distribution in large industrial plants. Numerical examples are given, demonstrating the advantages and limitations of the alternative proposals and showing the reasons for the choice of any particular size and rating of equipment.

The Aircraft Builders. By Nigel Balchin. London: His Majesty's Stationery Office. Price 9d.—This excellently produced and written booklet is an account of British aircraft production in the years 1935–45. It was prepared for the Ministry of Aircraft Production (now incorporated in the Ministry of Supply) by the Central Office of Information, and has just been published. At the peak of its activities in 1944 the aircraft production industry of Britain employed nearly 2,000,000 people, of whom about 40 per cent were women. The corresponding figure for 1935 was 35,000, prac-

tically all men. The figure of 2,000,000 people is about one-tenth of the total labour force in peacetime, and it made aircraft production by far the biggest industry in the country, employing more than coal-mining and agriculture put together. A refreshing account of the means whereby this enormous expansion was achieved and of the organisation, through Ministry and manufactu er, which so successfully and rapidly produced the "goods," is contained in thi publication. Referring to a single item of raw material supply—wood—we 'earn that five million trees had to be cut every year to supply the plywood used in aircraft construction. This wood was not the ordinary hardwood or softwood of commerce, but special aeronautical grades of birch, balsa, Sitka spruce, &c., which were frequently only obtainable from distant countries. In the light of such typical prodigious demands made on raw materials, it is not difficult to see the origin of some of the shortages of normal goods for civilian consumption. Paper for jettison fuel tanks, flax for covering the skeleton frame of the "Wellington," rubber, silk, nylon, cotton—it might reasonably be said that the British people gained air supremacy by using the clothes off their backs, the stockings off their legs, the writing paper off their desks, and the rubber off the soles of their shoes.

The Railways of Switzerland. London: *The Railway Gazette*, 33, Tothill Street, S.W.1. Price 5s. net.—This book has been issued in connection with the fourteenth International Railway Congress, which was held at Lucerne from June 23 to 28, 1947. It is a concise and comprehensive treatise on what many consider to be one of the most interesting railway systems in the world. The book opens with a concise detailed account of the development of the Swiss railway system and the policy of nationalisation which was adopted at the end of the last and beginning of this century. Following chapters deal with tracks, rack railways, Alpine tunnels, signalling, various forms of traction, rolling stock and traffic. Brief accounts of the Lötschberg, the South-Eastern and the Rhaetian railway systems are also given. The descriptive matter is illustrated by many excellent photographs, maps, diagrams and drawings. All who are interested in railways will find this book both interesting and entertaining.

BOOKS RECEIVED

Moulds and Presses for Plastic Moulding. By A. H. Sandy. London: Crosby Lockwood and Son, Ltd., 20, Tudor Street, E.C.4. Price 7s. 6d.

Newnes' Engineer's Reference Book. Second edition. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 42s.

Air Conditioning and Elements of Refrigeration. By S. P. Brown. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 30s.

The Water Engineer's Handbook and Directory. 1947 edition. London: Colliery Guardian Company, Ltd., 30, Furnival Street, Holborn, E.C.4. Price 15s.

Accident Prevention Administration. By F. G. Lippert. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, Aldwych, W.C.2. Price 11s. 6d.

Electricity and Fire Risk. Second edition. By E. S. Hodges. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 15s.

Structural Engineering. Fifth edition, revised. By Joseph Husband and W. Harby. London: Longmans, Green and Co., Ltd., 43, Albert Drive, S.W.19. Price 21s.

Controlled Atmospheres in Heat Treatment. By G. T. Dunkley. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 7s. 6d.

Fundamental Principles and Applications of Induction Heating. By "Heat-Treater." London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 10s. 6d.

Records and Research in Engineering and Industrial Science. Second edition. By J. Edwin Holmstrom. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 21s.

British Association

No. I

THE 109th annual meeting of the British Association is taking place in Dundee from August 27th to September 3rd, and a full programme has been staged by all the thirteen Sections. Three previous meetings of the British Association have been held in Dundee, but the one which is probably the most outstanding in the minds of those who were there—unhappily many who were there are no longer with us, having given their lives in the war—is the 1939 meeting, for on the third day it was necessary to abandon it owing to the declaration of war by Germany on Poland and there was a somewhat precipitate flight from Dundee on the part of the members of the British Association anxious to get home again. Other meetings in Dundee were in 1867, under the Presidency of the Duke of Buccleuch, F.R.S., P.C., and in 1912, under the Presidency of Sir Edward Schafer, F.R.S., on the occasion of which the late Sir James Caird made a gift of £11,000 to the British Association funds, and this led to the Caird Fund, which is devoted to scientific research.

At the moment, the figures of attendance are not available, but there is every sign that the 1947 Dundee meeting will be largely attended. Certainly, the topics down for discussion lose nothing by comparison with pre-war years; indeed, in the changing conditions of the world, many of them are of outstanding importance.

The President this year is Sir Henry Dale, O.M., G.B.E., F.R.S., who, following the long-established custom, gave his Presidential Address on the evening preceding the opening of the sectional meetings, this year on August 27th. Abstracts from this address are reproduced below.

Science in War and Peace

The Officers and Council of the Association have naturally wished that this meeting should take special note of the emergence of science, in Britain as in other countries, from its abnormal concern with war, and its return to the service of peace. To rally and to give direction to the thoughts of the members and of the sectional officers in this general sense, the phrase "Swords into Ploughshares" was suggested, and adopted by the Council, as a motto for the meeting. Even in its most obvious meaning, the metaphor will find abundant application in the coming week of discussions. Let me choose a few, almost at random, for mention now.

How many decades of research do you suppose, undertaken in response to no stimulus stronger than the desire to add to the resources of peace, would have been required for those developments of radiolocation and radar, which were achieved in a few years under the imminent threat and the realised peril of war? It is certain that the scientific activities of peace had never witnessed anything like the intimate collaboration of British and American physicists and engineers, which finally played so important a part in giving full effect to this triumph of science in the service of war, with its value, so immediate, for the safety of transport in peace.

Aeronautical science, having received a great stimulus in the earlier world war, and having undergone a steady development in the intervening years, sprang again into a phase of headlong progress under the threat and the experience of the new war. And now we wait to see what will be the effects, on speed and safety in peaceful transport, of gas-turbine engines and jet propulsion, of stratosphere flight in pressure cabins, and of the fundamental changes in aircraft design, which are all still under rapid development.

The needs of war, again, soon presented to engineering, on the one hand, and to physiology and experimental psychology on the other, a group of practical problems arising from the unnatural conditions of physical and mental stress to which men were exposed in the constantly developing machines of modern warfare—aeroplanes, tanks, submarines and the rest—as well as from the extremes of climate and the deprivations to which they were subjected by military necessity or accident. And the researches which were framed and conducted, in response to these varying demands, have produced a great volume of new knowledge concerning a variety of conditions which favour or hinder the different activities of man's body and mind, and their resistance to the influence of fatigue. War has thus enforced a lesson which surely should not be forgotten in peace, that machinery was made for man and not man for machinery.

The sectional meetings during the week will certainly have under discussion many more of such direct applications and extensions of discoveries and inventions made in war, to the ordinary needs and purposes of peace. These will constitute, however, only a part, and very likely not the most important part of the incidental and compensating gains of science itself, and of mankind through science, from this participation in the researches required by war. Scientific research may expect to obtain, from inventions thus made for special and quite unrelated purposes, new tools and facilities for the general advancement of natural knowledge over wide ranges. The development of rockets as weapons of extreme range, for example, may provide means for obtaining data of physical conditions, at altitudes from the earth's surface previously far beyond the reach of scientific exploration; and the great advances made in aerial photography will certainly find application for purely scientific surveys of various kinds, over land and sea. And, apart from many and great additions of this kind, to the physical and technical resources available to research, there will be lessons to be learned from war's experience of the methods of planning and organising research, of the recruitment of special research teams, of the value, for the rapid attainment of a particular objective, of co-operation on a national and, as in cases which I have quoted, on an international scale. All such experiences in war will have left lessons which may have value in peace, to science in the pursuit of its normal objectives, and to the world at large in a new understanding of what science can be expected to do, and of the ways in which its aid can be invoked.

It may be of at least equal importance that we and the world should, with all rapidity and thoroughness, forget other lessons, which ought to be discarded. It is hardly to be doubted that, to many scientists, the war brought opportunities for research under conditions which were, in various ways, and in spite of the strain and anxiety of the time, more immediately attractive than any that they had previously encountered. Comrade-

ship, effective even across some national boundaries, in work for a great cause, without thought of personal credit or recognition; an escape, perhaps, from indecision concerning the scientific worth or soundness of a line of personally chosen research, and from anxiety as to material resources for its pursuit, into a world of authority and planning, of problems posed by actual emergencies, of practical issues and tangible results, and of facilities without restriction; and a sense withal of high duty performed for the future of his country and of the world, by the use of a man's own special knowledge and skill, and not always without danger—duty as clear and unquestionable as others could only discharge by a sacrifice of all their normal instincts and interests and, for many, of life itself—all these conditions of scientfic war service may have given to many a man a different kind of satisfaction, from any which had come to him from the normal experience of a scientist in peace. Some there must be, to whom this conscription of science for war gave even their first opportunity of testing the joys of research, and of putting their own natural equipment for it to the test of performance. And I suggest that there may be danger to science from a tendency to transfer too easily and completely, to the activities of peace, the attitude to research and the traditions of its conduct which have been acquired during six years of such war experience.

Does anyone doubt that, to enable science now to render its best service to mankind, we need to take a long-range view and to give our first care to the extension of fundamental knowledge, unconstrained by aim at any practical objective? I am not concerned to advocate, or to defend a philosophy postulating the advancement of pure knowledge on the one hand, or the material betterment of man's lot in the world on the other, as the ultimate motive of the scientific effort. I believe that it would be admitted, by partisans of either doctrine, that research which seeks only to advance pure knowledge commonly leads in the end to the widest practical developments; and that examples are plentiful of practical researches, conducted under conditions which leave full freedom to follow side issues, opening the way to great fundamental advances. The concentration, however, of practically the whole of a rapidly growing scientific effort on practical applications and developments, such as the war has witnessed, might find instructive analogy in a rapid extension by a commercial undertaking of its trading enterprise, without care to conserve and to expand its working capital; or in a reckless cropping of land, without care to nourish the soil. In theory I think that this is generally recognised, and I am far from suggesting that any of the different authorities which now provide material support for science in peace will hesitate to give generous encouragement to fundamental researches. My fear is rather that we scientists ourselves may find it difficult to shake off quickly the spendthrift habit in research, the policy of trading for quick returns, which six years of war experience may so easily have fostered, and may even have made congenial to many of us.

I venture, further, to voice a hope that men with the rare, creative ability that science needs now for the resumption of its normal progress in peace, whose influence and example are needed in the schools for the inspiration of those who will follow, will not too readily assume, or too easily be persuaded, that their best service to science can still be rendered by planning and organising, or by bringing scientific ideas to bear upon policy. I believe that, under conditions now to be faced, the building up of our scientific capital of fundamental knowledge by those who have the creative gift, should have a prior claim over its practical exploitation and over any cultivation of its political influence.

A devotion so complete to the service of war as that which we gave in these recent years has involved many of us in obligations of secrecy entirely new to our experience; and there are important sections of scientific activity which have not yet been able to escape from these trammels.

How then are we men of science to deal with such a situation? With unquestioning loyalty to all our obligations; that first and foremost; but then also, I would urge, with a resolute watchfulness against any encroachment, on activities proper to peace, of a secrecy which we accepted as an abnormal condition in war, and with a determined effort to accelerate the liberation of science from all such entanglements. In the universities in particular, as I have elsewhere advocated, I hope that we shall be able to ensure that the scientists of the near future will grow up as we their predecessors did, in an atmosphere of scientific freedom, so that they may be ready to accept, in their turn, the duty of standing, at need, in the defence of science in its full integrity. And I hope that we can keep as the constant aim of our endeavour, in spite of all present difficulties and causes of discouragement, the revival of an intimate brotherhood of the men of science of all nations, working together in full confidence, once more as a world community.

In his Presidential Address to Section G on Thursday morning, August 28th, Sir William Halcrow spoke on the subject of "Progress in Modern Engineering." We print herewith the latter part of his address.

Cement and Concrete

Man has, since antiquity, required some bonding material in his structures, and it is known that the Egyptians employed a good lime mortar in the pyramid of Cheops. The Greeks and the Romans had this knowledge and the Romans developed a waterproof cement or lime which would set under water for use in their tanks and aqueducts by the addition of pozzuolana to lime. In passing it may be noted that the famous Roman aqueducts which were carried straight across valleys were probably the result of their lack of knowledge of the siphon principle. It has been said that the writings of Vitruvius were at least as valuable a guide as those of anyone else up to the early part of the nineteenth century when M. Vicat succeeded in producing hydraulic limes by grinding calcined mixtures of common limes and various clays. There were, of course, various hydraulic limes being produced at this time, and by 1824 Aspdin was producing what he called "Portland" cement. Frost, at Swanscombe, was producing "British" cement, but they were both what we would class as an improved and ground hydraulic lime. Little advance was made until about 1845 when Johnston, at the Swanscombe Works, burned the raw materials to near vitrification instead of calcining them and the resulting clinker ground into the first real hydraulic cement. Development proceeded slowly, and by 1865 the new cement could show better strength characteristics than the hydraulic limes and towards the end of the century lime was ousted from large-scale construction.

The past hundred years have seen the slow but continuous development of the material by careful selection and handling of the raw materials, and the ultimate strength of a practical concrete is about 6000 lb per square inch to-day as against 1730 lb per square inch in 1852. The chemistry of the processes involved is not fully understood even to-day, but during the past forty years an ever-widening range of consistent and high grade cements have been available for constructional purposes. We can suit the setting and hardening qualities of cement to individual purposes, and the latest addition to the range is a low heat cement for use in large masses of concrete like dams and dock walls. When setting, ordinary cement emits considerable quantities of heat for several years after casting, and this causes eventual shrinkage and important secondary stresses. Indeed, some dams have had cooling pipes built into the concrete to reduce these heat effects.

Plain concrete has a relatively low-tensile strength, and about the beginning of this century a composite material of steel and concrete was evolved. The steel was placed to take up bending and bonding tensions and the design, procedure and technique was soon worked out. So successful has this reinforced concrete become that it can be used with equal facility to steel for many load bearing structures. Indeed, its capacity for being tailored to the structure *in situ* gives it many advantages.

Ordinary reinforced concrete uses only enough steel to take up the tensile stresses induced by applied loads, and there is an inherent extravagance in that the concrete below the neutral axis of bending is theoretically unstressed and only used for holding the reinforcement in position. In the past twenty years another type of reinforced concrete has been evolved to overcome this. Instead of the steel and concrete being initially unstressed, a high tension is induced during construction in the steel and the surrounding concrete placed in compression. The superimposed loads then act on this initial stress system which can be so arranged that the final conditions of stress make use of all the concrete. This pre-stressed reinforced concrete results in large economies in the mass of material used, but there are several drawbacks at present. Very high grade concretes and steels are required and this involves a much greater degree of control during construction. The pre-stressing of the high-tensile reinforcement is not simple under practical conditions and the process has not yet achieved general use. It has, however, ever widening applications as the constructional technique is simplified.

Soil Problems

Earthworks are probably the oldest branch of engineering, but it can hardly be said to have changed from an art to a science until fairly recent times. With the establishment of the Industrial Revolution, involving the construction of canals, railways, roads, dams, &c., and all the adjuncts of an industrial society, the necessity for a fuller understanding of the qualities of the soft materials of the earth's crust became more urgent. Great cuttings and embankments involved so much capital outlay that rule-of-thumb methods of design were no longer sufficient. The earlier half of the nineteenth century was, however, the great period of refinement by experience. By 1857 Rankine had produced his paper on the stability of loose earth, and the design of retaining walls and foundations became possible under certain conditions. Unfortunately the formulæ and methods tended to be misapplied to all sorts of earth conditions including clays, and the resulting failures did not establish confidence in analytical methods.

By the latter part of the nineteenth century

it was economically necessary to make use of areas of soft materials which had hitherto been avoided. Industrial society was spreading its towns and works over great areas of clayey and silty land and constructional problems were severe. Direct loading tests on those materials suffered from limitations which were not always realised and failures naturally occurred.

In the early part of the present century several important investigations of landslides and soil problems were under way, and in 1915 Bell read his paper to the Institution of Civil Engineers on the lateral pressure and resistance of clay. This was a mathematical approach and did not treat in detail the structure of cohesive materials. In the early 1920's, however, the science of soil mechanics can be said to have started its rapid development stage when Dr. Terzaghi began to publish his detailed and penetrating analyses of cohesive and other soft materials. It was shown that the factors involved in clay were those of colloidal and near colloidal particles, of electro-static bonds between particles and of forces due to capillary water as well as the normal gravitational forces. Terzaghi's work was so detailed that by the middle 1930's the science was already an accepted basis of design and most major Governments had established specialised research departments.

The position to-day is that by examination of undisturbed samples of soil we can estimate within fairly close limits allowable bearing pressures, settlements, porosities, &c., of cohesive materials and we know the limits within which the early formulæ for lateral pressures are applicable. We do not know several important facts exactly, but we understand the limits and the tendencies much better.

Another branch of the same problem is that of soil stabilisation mainly in connection with road works. The fame of Roman roads becomes more than justified when we realise that it was only towards the middle of the nineteenth century that we again began to approach their standards of road construction. During the intervening 1500 years one can only marvel at the incredible and unsolved difficulties of cross-country travel.

In the early nineteenth century McAdam developed what is now called waterbound macadam, and after another hundred years the use of bituminous materials for binding the macadam spread over the civilised world mainly because of the growing pressure of motor transport. Although it cannot be said that the arterial road system evolved in this country is very inspiring, it should be pointed out that my firm were concerned in a scheme for a motor road from London to Brighton in the early days of the century. This was to be a toll road for motor traffic only and was of railway standards in regard to grades and curves.

In other countries, however, the construction of motor roads proceeded rapidly, and there is no doubt that this, allied to our tax system, has helped foreign manufacturers to pass us in the development of motor transport.

In undeveloped countries there is always a great necessity for cheaply constructed roads, and the so-called "dirt road" is a very important part of their economy. There have been continued efforts over the past thirty years to achieve stable surfaces at the lowest possible cost ranging from soil cement mixtures through soil chemical mixtures to oil or molasses-bound mixtures. The first is simply an artificial hard surface; the second a method of controlling the moisture content; and the third a waterproofing and binding process. Water content is the key to most soil stabilisation problems and a technique of grading and compacting has been established. The natural progression is to waterproofed surfaces where the climate is wet and many airstrips during the past war were covered with P.B.S. (prefabricated bituminous surfacing) which was simply rolled off in strips like wallpaper. In the Pacific theatre, oil, as a dust layer and stabiliser was much used.

Reverting to the use of chemicals on soils, we are now able to charge pervious water-bearing granular materials into artificial rock by the injection of certain chemicals. This is a very useful process when dealing with excavations, as we solve both the excess water and strength problems in a single operation.

Sometimes it is only necessary to provide a relatively impervious curtain under, say, a river barrage, and injections of finely divided bituminous materials have been successful in filling the pores of natural sands.

Clays cannot be treated by any of these methods as the pore space is too small. For the same reason they drain but slowly. Clays have been hardened, and drained, however, by electrical methods, and works which would have been impossible in the natural material have been carried out. The consumption of electricity is too high for widespread commercial usage at present, and, at any rate, the method has only a limited value in some types of clay.

Tunnelling is another very ancient and important form of earthwork. Indeed, its antiquity becomes quite startling when we consider the subterranean refuges, often formed in rock, into which our prehistoric forbears disappeared when threatened by danger. It is fairly certain, in Ireland at least, that this practice was the origin of a tradition of belief in pixies who could disappear inexplicably. No doubt these early men knew how to crack rock by alternate heating and quenching with water, just as the Romans certainly knew, and indeed the method is still in use in some quarrying operations to-day.

A roadway tunnel through the Alps was started though not completed as long ago as 1450, but we can say that modern tunnelling practice is largely the outcome of the accumulated experience of the past hundred years or so.

A century ago black powder was the only explosive used, but it has now been entirely superseded by gelignite or similar high explosive. Liquid air has been used, but generally in surface work only, as there are disadvantages involved in its volatility. At that time, also, handwork was used in drilling and clearing, haulage was by man or animal power, lighting by oil lamps, and ventilation fortuitous. It was in connection with the Mont Cenis tunnel that power drills were devised and first used in 1861, and the great physical difficulties involved on other Alpine tunnels provided a great forcing ground for the refinement of tunnel technique. To-day the tunnel is well lighted and ventilated during construction, whilst rapid drilling with pneumatic drills, clearing by mechanical diggers or scrapers and mechanical haulage are all arranged in a co-ordinated effort which tends to rapid progress and economy.

When we consider tunnelling in soft ground we meet another range of problems. Generally the walls, roof and sometimes the floor have to be supported by various methods like timbering, lining with brick, concrete, cast iron, or steel. When water troubles are experienced the work can be carried on in compressed air or by consolidation of the material artificially as mentioned before. In many cases the use of a shield at the working face is either necessary or economical.

The first shield was patented by M. I. Brunel in 1818 for use in the construction of the first Thames tunnel, which must rank as a major engineering achievement considering the difficulties involved. The next shield was designed by Greathead for the Tower Subway, and this was the prototype for the modern shield which can cater for a considerable range of earth conditions. With a modern shield and mechanical excavation a 12ft Tube tunnel in London clay can be advanced by as much as 160ft per week.

Harbour Works

When we recall the Mole and Pharos at Alexandria and the lay-out of some other classical harbours we realise that the historical maritime civilisations of the Mediterranean had available a great measure of technical ability. Indeed, there is some doubt as to whether the intervening period up to about the eighteenth century was one of progress at all. Men had continued to off-load ships on to shores or small wharves and commerce was so small that there was little urge to do otherwise. By the early eighteenth century, however, commercial maritime transport was growing in importance and wet docks were becoming a necessity. A slow steady progress was maintained, with wharves and port ancillaries growing larger as the size of ships increased. Up to the end of the last century much of this work was carried out in the traditional cyclopean masonry, but with the development of concrete this form of construction became modified in many circumstances, as the walls coulo be cast *in situ*. The use of reinforced concrete in place of the traditional timber enabled heavier jetties and wharves to be constructed, but development was really only in the increased scale of works. In the present century we have seen a number of interesting changes, for example, in the development of steel sheet piles which enable wharves to be built with considerable speed, in the development of iron screw piles into steel screw cylinders with greatly increased range of usefulness, and in the development of constructional technique like the well-point system of ground water lowering.

The recent war saw a great increase in what is called prefabrication. This can be defined as the practice of partially fabricating structures in the shops so that they may be assembled rapidly at the final location. The idea is not new, nor is it always economical, but the scale on which it was practised during the war is certainly new and may affect certain changes in peacetime construction.

The story of the invasion harbours is too well known to repeat here, though they were the crowning achievement of prefabrication. Less publicised were the permanent wharves for the heaviest loadings which were built in some of the Scottish sea lochs. These were built by screwing down steel and concrete cylinders 3ft in diameter into the bed of the sea and then placing a prefabricated concrete deck on top. Speed of construction was considerable and the wharves handled a large part of the U.S. armed forces entering this country.

Further south, large forts complete with guns were built in dockyards and floated out to the required sites in estuaries where they were sunk in position to form fixed strong-points.

Models and Experimental Analyses

With the ever increasing complexity of the technical demands of society we have had to handle problems which are either not susceptible to mathematical analyses or only

laboriously and impractically so. In consequence we have developed analysis by experimental methods to a considerable pitch. For direct stress measurement the electrical resistance strain gauge has been much used recently for a wide range of problems. When we have to consider internal stresses in structures the practice of photo-elastic analysis is of great value. As long ago as 1816 Brewster noted that strains in crystals affected their optical properties, and since then the effect has been developed into a process in which scale models made from a clear medium like celluloid are stressed and analysed by polariscope. In the main only two-dimensional problems are considered, but three-dimensional analyses can be carried out within limits. Though it cannot be said that photo-elastic methods are either simple or flexible, they have been our only practical approach to many problems. More recently, Professor Southwell's relaxation methods of mathematical analysis have proved useful in a great range of problems.

Another great field of experiment is that associated with fluid dynamics. Aerodynamics is now one of the major sub-sciences, and its success can be gauged by the fact that very few aircraft failures to-day can be traced to poor aerodynamic design. Much of the research effort to-day is directed towards the piercing of the sonic barrier, and, though we have reached velocities approaching that of sound with conventional aircraft, the next step will depend greatly on wind-tunnel models and probably as much so on free flying models, fitted with automatic recording and transmitting apparatus. In civil engineering the importance of aerodynamics is not so great, but the recent failure of the Tacoma Narrows suspension bridge in a 30 m.p.h. wind has heavily stressed the necessity for aerodynamic investigation in cases where structural oscillation can occur.

Hydrodynamics has probably greater capital importance even than aerodynamics, and as long ago as 1872 Froude carried out his famous work on the resistance to motion through water. Since then the use of scale models has produced great improvements in hull forms, from barges to the largest liners. More recently it has been possible to represent the behaviour of vessels by self-propelled models and, indeed, the technique is now so refined that it is of value in arbitrations as, for example, in the case of the collision between the "Queen Mary" and H.M.S. "Curacao."

Much of the handling technique as well as design of components for the invasion harbours was worked out in laboratory tanks with consequent saving in the time required to instruct Service personnel in their use.

One of the great commercial marine problems is that of alterations in existing *régimes*, *e.g.*, silting and erosion. For this purpose a model concerned with improvements to the Garonne was constructed as long ago as 1875. The first really scientific models, however, were built by Professor Reynolds at Manchester University and Professor Gibson's model there twelve years ago in connection with the Severn Barrage is now classical. By a suitable choice of scales and materials it was possible to reproduce seventy-eight years of the history of the estuary closely and by inference the future can be foretold. Several models have since then been constructed for various estuaries, ports or rivers in all parts of the world with considerable success.

A new laboratory under the direction of Sir Claude Inglis is being set up in this country by the Hydraulics Research Board of the Department of Scientific and Industrial Research, and one of its first works will be a new model of the Severn Barrage, as the lay-out has been changed since Professor Gibson's model was in use, and local rearrangements to the flow at the barrage will take place.

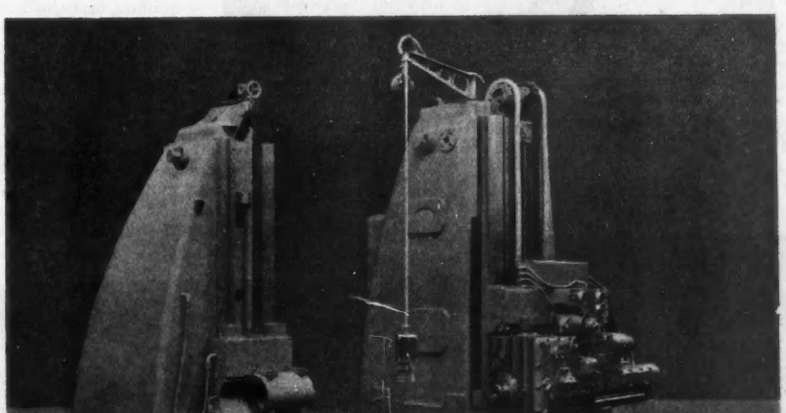
In the construction of dams one of the more important aspects is the disposal of flood water over or around the structure. When we consider that even a medium catchment area in this country can produce several hundreds of tons of flood water per second a considerable amount of energy has to be dissipated if the water flows over the crest of the dam, which may be upwards of 100ft high. Where sound rock occurs near the surface, the solution is simple, but where this is not so, considerable excavation for spillways may be necessary, and economy in design becomes very important. Models in laboratory conditions are very useful for this purpose and refinement is such that costly remedial measures after construction are no longer justified. By a suitable arrangement of slopes and cills we can make the water itself do most of the work—the kinetic energy being changed to potential energy in the form of depth.

Similar model methods can be applied to a great range of hydraulic problems ranging from erosion at weirs and bridge piers to the silting of canals and the prevention of dangerous ice jams in intake ponds.

(To be continued)

A Large Horizontal Boring and Milling Machine

A NUMBER of interesting features have been incorporated in a boring and milling machine which has been developed by the French "Société Nouvelle de Construction de Machines Outils et d'Outillage, Procédés C W B," and is now being built by George Fischer, Ltd., of Schaffhouse, Switzerland. It is built in three sizes, having spindles of 2in, 3½in and 5½in diameter. These new machines are designed for a wide range of work, including boring, surfacing, horizontal and vertical milling, drilling, tapping, counter boring, and, with a special attachment, copying. The photograph which we reproduce above shows the largest of the three machines, and, although the dimensions given in the following description apply only to that machine, the general constructional features are common to the other sizes.



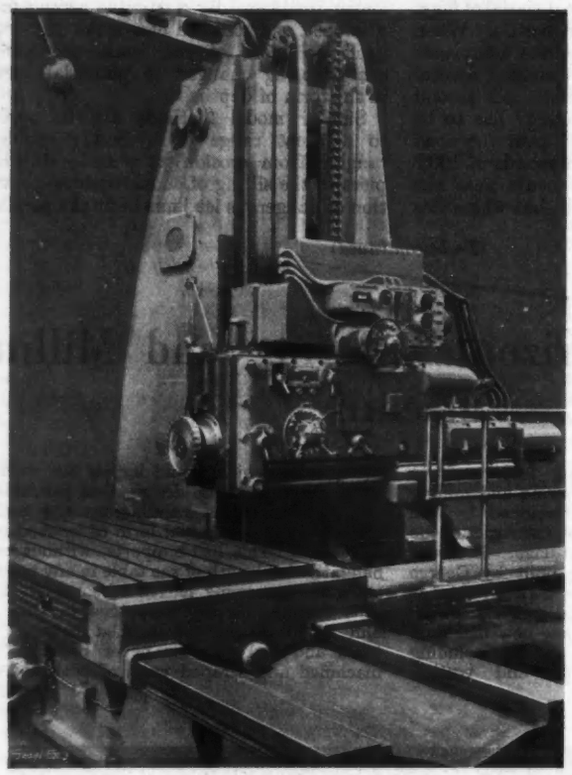
BORING AND MILLING MACHINE

The main bed of the machine is 20ft long and is designed to carry a table 4ft 8¾in wide by 10ft 10in long, although we are informed that two alternative tables 14ft 2in and 19ft 1in long, with correspondingly longer beds, can be supplied if required. As will be appreciated the bed is highly stressed and has to support very heavy loads during machining and, to eliminate any tendency towards deflection or deformation which would impair the working accuracy, it has been designed on particularly rigid lines. For its manufacture the builder has developed a special form of webbed reinforcement. This bed supports, without overhang, the full length of the table in any position along its traversing length of some 8ft 2½in. This feature has an advantage in that the film of lubricating oil formed between the table and bed ways is never broken. The machined and scraped ways of both bed and table have a degree of accuracy which, in conjunction with the rigidity of the design, is stated to give a true horizontal table travel within 0·0002in per foot.

Rigidly fixed at right angles on each side of the main bed are secondary beds of similar design, one carrying the main boring head column and the other the boring bar support column.

The boring head column is of box-form construction and can be traversed for a distance of 3ft 3⅜in along its bed. The head assembly traverses vertically along ways for the full height of the column, to permit a boring bar spindle centre adjustment the level of the table to a maximum height of 6ft 6⅜in above its surface. The boring head itself is

mounted on a horizontal cross-slide in which it can be moved over a length of 19½in on the column. This feature serves to reduce the necessity for tool overhang, particularly when heavy face milling cutters are mounted on the head and the work surface is set in from the side of the table.



BORING HEAD WITH FACE MILLING CUTTER

In order to maintain the high initial degree of accuracy of the machine the main spindle is so arranged that the means of support and drive for heavy duty milling and similar work is distinct from that for the lighter boring operations. It consists basically of a large diameter spindle, mounted on heavy duty bearings, and having a secondary spindle running within. As can be seen from the photograph we reproduce herewith, face milling cutters can be bolted directly on to the outer face of the large spindle, whilst the lighter inner spindle is not stressed in any way, irrespective of how heavy a cut is being made. The large outer spindle has no independent longitudinal movement, but is adjusted and fed into the work by traversing the complete head longitudinally along its ways. This means of rigidly supporting the tool permits the application of full power when milling with heavy duty cutters and adapts the machine for use with carbide tipped and negative rake cutters. The inner drilling or boring spindle has an independent longitudinal movement of 39½in. The face into which the spindles are set is machined and scraped and can be used as a datum face for setting purposes. It is also designed to accommodate a range of subsidiary equipment used for vertical and universal milling, and the drilling and tapping of holes.

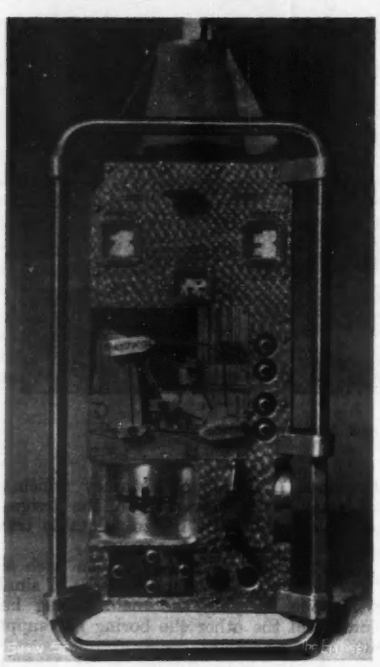
The weight of the boring head is counterbalanced by hydraulic means within the column. All slide movements are effected by electric motors under push-button control from the operator's platform, which is part of the head assembly and moves up and down on the column with it.

The boring bar support column is adjustable along the slides of its bed for a distance of 39½in. As the lead screw actuating the slide of the boring bar bearing is subject to much less wear than the screw which controls the height of the boring head the motors driving the two screws are not interconnected for adjustment purposes. A special optical device is fitted to the bar-bearing slide so that the axis of the support bearing and that of the boring spindle can be accurately aligned when necessary. It is claimed that by the use of this optical device an accuracy of alignment between 0·00012in and 0·00024in per foot can be attained.

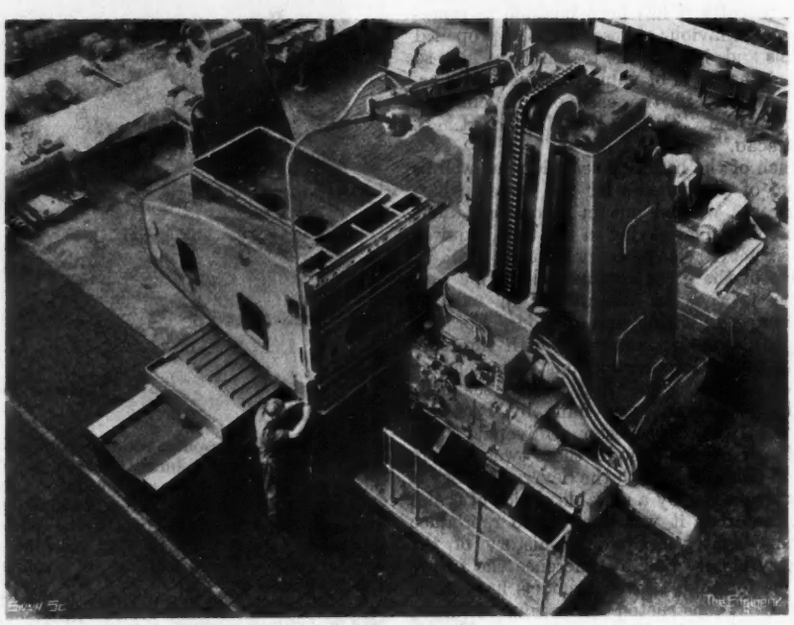
On a machine of this size the locking of various slides, &c., is of particular importance. So as to carry out the locking operations effectively an electro-hydraulic system of the maker's own design is used. With this system the clamping pressure on the unit being clamped is so arranged that whilst it is rigidly locked, the supporting medium is in no way disrupted. Also, the clamps are so designed that there is no tendency for the unit to move during the locking operation. The control gear of the motors actuating the slides and spindles is designed to stop the motors instantly without shock. We are informed that by the arrangement of appropriate trips on the various slides the machine can, within limits, be set to perform a definite cycle of operations, at the end of which it automatically comes to a stop.

The machine has been designed with a wide range of stepless speeds and feeds to meet the requirements of the various types of machining for which it is adaptable. The feed ratio of variation is in the order of 1 : 1600 and the spindle speed ratio is 1 : 300. The boring spindle motor develops a constant torque from about 10 r.p.m. up to 500 r.p.m. Speeds and feeds can be varied during the actual working cycle without stopping the machine. This means of stepless feed variation makes it possible to feed the tool slowly on to the work, accelerate to full working speed when the tool is fully engaged with the workpiece, and, when disengaging the tool, to reduce the speed.

In order to save the considerable amount of time and energy which would be used by the operator of such a large machine in moving to and from the usual control panel during machining and when setting a large job on the table, the mobile pendant control box illustrated herewith has been developed. This control box is slung from a pivoted arm projecting from the top of the boring head column, and the operator can swing it around with him as he moves round the workpiece on the table, as well as regulate its position in the horizontal and vertical direction by means of a push button placed on the box itself. He can thus bring it to the immediate vicinity of the spot of the workpiece where the actual machining is taking place.



PENDANT CONTROL BOX



FACE MILLING A LARGE CASTING

The whole machine is electrically controlled from this box. Both the spindle speeds and feeds are push button controlled and the speeds and feeds selected are indicated on suitable dials. The adoption of push-button remote control eliminates the necessity for an operator to manipulate a multiplicity of levers, &c., when speed or feed changes are required, and to move away to the control panel in order to do so. Direction of spindle feed, start, stop and stepless speed changes of spindle rotation and feed are also push button or trigger controlled. Similarly, all slides and moving units, such as headstock, column, or table are unlocked, moved to the desired position and then relocked by remote control when the appropriate push button is pressed.

The Air Cycle Heat Pump*

By T. F. THOMAS, M.Sc.Tech., A.M.I.Mech.E.†

(Continued from page 181, August 22nd)

The Air Cycle as Air Drying Machine.—If it should be found practicable—*e.g.*, by a washing process—to remove the condensed moisture from air expanded to a temperature below the dewpoint, then the air cycle might be adapted to produce warm dry air for evaporative drying processes at a cost which should certainly compare favourably with electrically heated air used in open-circuit driers, and possibly with steam-heated air dehumidified by means of refrigeration plant in closed-circuit driers.

In the simplest case of non-recirculated air expanded, to dehumidify it, and then recompressed to heat it to the required temperature for drying, no heat exchanger is involved; the efficiency of the process can be measured by the air drying ratio R_D. In Fig. 5 the curves show the value of R_D for such a simple cycle assuming :—

	Per cent.
Initial humidity	100
Final	100, 80, 60 and 40
Efficiency of compression = efficiency of expansion	80

A reduction of the initial humidity to 60 per cent relative humidity shifts the curves down

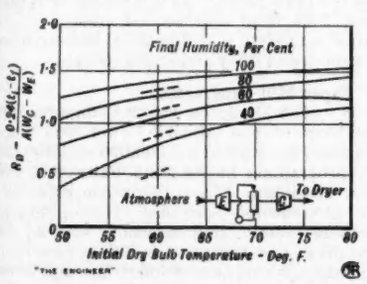


FIG. 5—*Performance as Air Dryer*

	Per cent.
Initial humidity :	
Full lines	100
Dotted lines	60
Efficiency of compression	80
Efficiency of expansion	80

slightly, as indicated by the points calculated for the sample initial dry bulb temperature of 60 deg. Fah. It may be observed that for the value of $R_D=1$ the corresponding value of kilowatt-hour for 1 per cent of moisture removed per ton dried (*i.e.*, the latent heat of 22·4 lb of moisture) is only about 7·0kWh, which indicates that the process would compare very favourably with direct electric heating as used, for example, in grain drying.

For an example of a drying process with a closed cycle, let us assume a required atmosphere given by the first line in Table III.

It is assumed in this example that the warm air leaving the drying apparatus is first cooled in an air cooler (using fresh water at the atmospheric temperature of 55 deg. Fah.), in which the air is cooled to a temperature of 65 deg. Fah. The air then passes to an air turbine, which expands the air down to an assumed minimum temperature of 33 deg. Fah. It would not be necessary in this example to cool to quite such a low temperature, but since the control of the duty of the plant is assumed to be secured by the very simplest form of control—*i.e.*, an air cooler on the discharge of the conditioning plant to the dryer—it is proposed to allow for a generous margin in the cooling capacity and take what might be considered to be the minimum temperature at this point.

After expansion it is assumed that the moisture is removed by a washer; the "dry saturated" air is then admitted to the air compressor and returned to atmospheric pressure. This is the point 5, Fig. 4. Temperature control cooling reduces the temperature to 117·5 (state point 6) and cooling at constant total heat in the drying plant takes place until state point 1 is reached at 40 per cent relative humidity, when the air is extracted and returned to the water-cooled air cooler.

TABLE III.—*State Points ; Example B*

State point	Description.	Dry bulb temperature, deg. Fah.	Wet bulb temperature, deg. Fah.	Relative humidity, per cent.	Total heat, B.Th.U. per lb.	Weight of moisture. Grains per lb.	Weight of moisture. Lb per lb.
1	Extracted air	91	72	40	28	88	0·0126
2	After atmospheric cooler	65	63·9	94	21·6	—	—
3	Dewpoint in expansion	63	63	100	—	88	0·0126
4	Turbine out	33	—	—	—	46·9	0·0067
5	Compressor out	125	—	—	—	46·9	0·0067
6	After control	117·5	—	—	28	46·9	0·0067
7	Cooled air	38	38	100	6·6	34	—

The power consumption is given in Table IV, where some comparative figures are included for the power consumption of refrigerating plant to give the same performance assuming fresh water-cooled air at 38 deg. and air heating to the temperature required (state point 8) to obtain the required conditioned atmosphere without further adjustment.

TABLE IV.—*Power Consumption ; Example B Heat Pump Scheme*

Heat rise by compression...	22·1 B.Th.U. per lb dry air
Heat drop by expansion ...	14·2 B.Th.U. per lb dry air
Net work	7·9 B.Th.U. per lb dry air
Power consumption (motor efficiency 0·9)	9·85kW per 1 per cent moisture per ton per hour
Cold Water Dehumidifier and Air Heater	
Refrigeration required ...	3·63 tons, say, 3·5kW
Heat required for air heater	0·611 therms per 1 per cent moisture per ton
Heat required for electric heating	17·9kWh per 1 per cent moisture per ton
Total as electricity	21·4kWh per 1 per cent moisture per ton

The Heat Exchanger.—The heat exchanger, which would appear to be the simplest part of the apparatus, is in fact no easy engineering proposition.

In perhaps no field of engineering has there been a greater expenditure of money and labour in investigating phenomena, together with such unsatisfactory mechanical arrangements for applying the results to practice, as in the field of heat transfer. The essential requirements for a heat exchanger for two gas flows of approximately equal quantities of gas are as follows :—

(1) Transfer of heat with minimum temperature difference between gas streams in contra-flow.

(2) Minimum dissipation of energy by friction.

(3) Suitability to withstand a moderate pressure difference across the heat exchange surface.

(4) Facility for cleaning both sides of the heat exchange surface (more especially for open-circuit cycles).

(5) Minimum cost and volume.

Many existing designs of air to air heaters provide simply a nest of tubes in which one flow passes through and the other across the tubes.

The criterion of the merit of a heat exchanger is the ratio of the heat transferred to the energy dissipated in flow through the apparatus. If we take the heat transfer rate as the temperature rise in one gas stream, per unit temperature difference between the gas streams, and relate this to the energy loss as pressure drop of one stream, per unit absolute pressure of that stream, we then have a useful non-dimensional heat exchanger performance factor

$$E=\delta t/\theta \cdot p/\delta p,$$

in which δt, δp and p signify temperature rise, pressure drop and absolute pressure of one gas stream, and θ the temperature difference between gas streams.

It must be noticed that the overall temperature difference θ is composed of $\theta_1+\theta_2$, the temperature differences between each gas flow separately and the temperature of the heat transfer surface. Test data will give the value of this criterion E_1 referred to one side of the heat transfer surface.

Analysis shows that, for both through-tube and across-tube flow the heat transfer factor can be represented by an equation of the type

$$E_1=XYd^2p^2T^{-1},$$

in which X is a function of the Reynolds number and Y is a function of the properties of the gas including the Prandtl number, and d, p and T are the tube diameter, gas pressure, and absolute temperature respectively. It is therefore possible to represent the performance of a tubular heat exchange element for air, say, by plotting E_1 against the Reynolds number for particular values of d, p and T, while the characteristics of other types of heat transfer surface may be represented on the same graph in a similar manner. In Fig. 6, E_1 has been calculated from the expressions for heat transfer and pressure drop given in Professor Lander's paper to the Institution for the two common cases of the flow through and across plain tubes

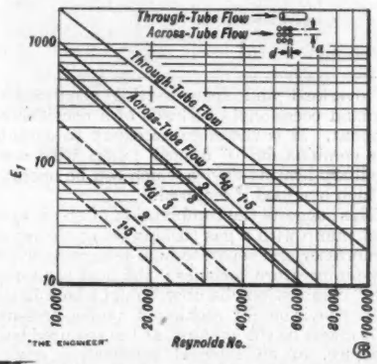


FIG. 6—*Performance Factor for Heat Exchanger with Air*
Chart drawn for $d=1$in ; $p=15$ lb per square inch ; $T=590$ deg. Fah. abs.; and physical properties of air $E_1 \propto d^2p^2T^{-1}$. The Reynolds number is based on maximum velocity for full lines and on frontal velocity for dotted lines.

(with the introduction into the through-tube pressure drop expression of a friction coefficient varying with the Reynolds number).

The unequal performance of through-tube and across-tube flow is emphasised when the across-tube flow performance is plotted against a Reynolds number based on the frontal air velocity, instead of the maximum velocity between tubes, although it is actually upon the latter that the heat transfer coefficient depends. It is required to find a surface which has a high value of E_1, is easily cleaned, pressure resisting and economic. The briefest consideration of this question shows what a wide field is here open for invention, the application of which is of great importance to the development of both gas turbines and heat pumps.

The Pressure Exchanger.—There seems to be little scope for improvement in the efficiency

* Institution of Mechanical Engineers, March 28th Abstract.

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of compressors and turbines when axial-flow compressors, handling quantities of the order of 100 lb per second, attain efficiencies of 90 per cent and the performance of centrifugal compressors and turbines for low temperatures and pressure ratios falls not far short of that figure. Nevertheless, the objective is adiabatic change with the compression of one gas flow and the expansion of the other taking place in one and the same machine; that is, a machine which secures pressure exchange between the two gas flows at constant entropy. There would appear to be considerable scope for investigation here. A machine consisting of a single rotating element which, it is claimed, produces standing waves of compression and rarefaction due to shock at subsonic flow velocities in two separate streams of gas—so that they mutually exchange their pressures—has been invented by the Swiss engineer Lebre (Brit. Patent 553,208 of 1943). It was reported in 1939 that a machine of this kind, designed for an output of 1 therm per hour, had reached a performance ratio of 2·3 on test; the figures quoted corresponding to a value of $R_f = 4 \cdot 1$.

If pressure exchange is to be secured by setting up, in the two separate gas streams, vibrations whose amplitude covers the desired pressure ratio, then it appears necessary to arrange for the frequency of vibration to be either above or below the audible range. The Swiss engineers appear to have solved the problem at a frequency above the audible limit, but the low frequency possibility would seem attractive for handling small quantities of gas for which the turbo-compressor is unsuited.

Heat Pump with Fuel-Fired Heater.—The air cycle heat pump depends on the use of motor-driven machines, which are not very convenient for adjustment of duty by speed control without considerable elaboration and cost. Furthermore, the characteristics of such machines are such as to make them unsuitable for operating

TABLE V.—*Heat Operated Heat Pump (Ideal Cycle)*

Pressure ratio (low-temperature turbine)	1·5	2·0	3·0
Pressure ratio (compressor)	4·0	4·0	4·0
Temperature rise in combustion heater, deg. Fah.	44	139	749
Maximum temperature, deg. Fah....	360	455	1065
Performance ratio, R_p ...	2·23	1·63	1·18

at overload and space-heating requirements demand occasional overloads of a considerable amount. It is therefore necessary to consider the combination of a heat pump with some auxiliary heating device which can be operated at high overload if required.

This suggests the combination of an air cycle heat pump with a gas turbine using a common compressor and separate high-temperature and low-temperature turbines; the heat source for the "combustion chamber" might be a heater with provision for stoking it under pressure, or it might be the exhaust, at the required back pressure, of an internal combustion engine. Alternatively, the combustion chamber could be a flue gas type of heater arranged in the flue of a normal hot water boiler—which is usually required in such buildings as are under consideration for this application of space heating.

If we consider the very simplest case of a heat pump driven by a heat supply between the compressor and the engine (air turbine) E.1 in Fig. 1 (*g*), then we obtain the results in Table V based on the assumption of atmospheric temperature of 30 deg. Fah., room temperature 60 deg. Fah. and pressure ratios for the air turbine E.2 of 1·5, 2 and 3. The calculation has been made assuming constant specific heat of air, the maximum temperature being about 1000 deg. Fah. for the worst condition.

ALLOCATIONS OF TIN METAL.—The Ministry of Supply announces that the Combined Tin Committee has made a further interim allocation of tin metal for the second half of 1947 amounting to 15,710 tons. This allocation is in addition to a first interim allocation of 11,331 tons announced on July 8th.

Canadian Engineering Notes

Radar Aid for Harbours

The National Research Council of Canada and the Department of Transport are co-operating to determine what use can be made of radar at harbour entrances. Considerable work has already been done on this matter. The equipment now in use is at the Camperdown Signal Station overlooking the entrance to Halifax harbour. It is now possible to view incoming vessels during any conditions of fog, storm and darkness to a distance of 25 miles. The Sambro light vessel, anchored 11 miles off this point, is clearly visible at all times. Its position marks the approach channel for vessels inward bound from the south and west. The outer automatic gas buoy is also always clearly visible and marks the channel for vessels approaching from the east. The height of the radar installation at the Signal Station is such that inbound vessels can be followed and plotted from a distance of 25 miles with extreme accuracy. An accuracy of plus or minus 50 yards is obtainable to maximum range. It is thus possible for the shore base signal men to report inbound vessels from a greater distance than was previously possible even in clear weather, and this condition exists during all types of inclement weather that previously prevented reporting of inbound vessels. An additional attachment to this installation provides a continuous view of a harbour chart with a radar picture superimposed upon it from Chebucto Head to Devil's Island, McNab's Island and Sandwich Point. All buoys are visible continuously on this superimposed chart and the pilot vessel and ships can be plotted as they proceed on different courses from buoy to buoy. Experimental work is also under way for positive identification, by radar, of inbound vessels, so that in the not-too-distant future there may be no doubt as to the identity of a ship receiving radar aid for the approach to the pilot station or the harbour entrance. These radar aids would, of course, only be necessary in instructing inbound vessels if they are not already equipped with radar.

Paper Mill Expansion

A modernisation and improvement scheme for the Kenora, Ontario, mill of the Ontario-Minnesota Pulp and Paper Company, Ltd., has received new impetus in the form of authorisation to spend an additional 750,000 dollars, bringing to more than 1,500,000 dollars the total cost of the scheme. Included in the work to be undertaken is the modernisation of the company's No. 6 paper machine, rehabilitating it from newsprint production to the manufacture of high-grade groundwood printing papers. Construction is expected to start immediately on the company's Rainy River pollution elimination facilities to recover and dispose of bark fibres and other refuse resulting from wood room operations. In addition, a Sveen-Pederson save-all unit will be installed further to reclaim fibres, preventing them from entering the river along with excess white water. Other projects soon to be started or under way include replacing two boilers in the company's Fort Frances steam plant with a single unit producing 85,000 lb of steam per hour, building of mill and logging stores, additional barking drum facilities, extension of finishing and shipping rooms and extension of No. 3 groundwood mill.

Airport Improvements

Canada's Malton Airport, 18 miles outside Toronto, is to be reconstructed and ultimately will become one of the most modern airports on the North American Continent. The present administration building, hopelessly inadequate for the task of handling passengers from sixty to seventy flights daily, is to be completely overhauled and new buildings constructed. Runways have already been lengthened to 5000ft, to accommodate the largest transport aircraft in use. Present loading platforms will be extended to accommodate large aircraft, such as the "DC-4," while in a nearby hangar the Central Aircraft Company will be equipped to do all overhauling, servicing and repairs in addition to present trans-Canada facilities. While contracts for the work have not yet been let, engineers have already started sinking pits for soil tests to determine if piling will be required to support the new building.

New Hydro-Electric Power Scheme

A new power plant is to be built on the Mississauga River, in Northern Ontario's Algoma district, fifty miles east of Sault Ste. Marie. The cost of the scheme, which is to be constructed by the Ontario Hydro-Electric Power Commission, is estimated at 19,000,000 dollars. The new plant will develop current at a frequency of 60 cycles, which will be fed into the area through a frequency-changer station at Sudbury. The area now is supplied with both 25-cycle and 60-cycle power. Plans call for driving a temporary tunnel through rock to divert the river while the main dam and power-house are built in a rock gorge 90ft wide. A storage dam is to be constructed at Rocky Island Lake, about forty miles north of the tunnel site. The main dam will give the plant an operating head of 215ft. Industries in the area to be served by the plant include the International Nickel Company's nickel and copper developments and the Falconbridge nickel mine in the Sudbury district. The Mississauga development, which will produce 56,500 h.p., is the seventh scheme planned or under construction by the Hydro-Electric Commission. These schemes provide for a total expenditure of 86,000,000 dollars.

Signal Repair Shop

An important new addition to the maintenance, repair and construction shops of the Canadian National Railways at Point St. Charles, Montreal, has been announced by Mr. Burton Wheelwright, chief engineer for the system. The new shop will centralise the complete signal repair work for the whole of the C.N.R. in Canada at Montreal and, in addition to the repair work, will permit manufacture of new signal material to a degree, thus resulting in a marked saving through elimination of duty. Formerly, the bulk of this signal work had to be done in the United States. The new signal shop will be of reinforced concrete throughout with red brick facing. It will consist of a basement, first floor and second floor and will contain a modern machine shop, battery room, dark room and relay and stores room.

Paper Mill Programme

The Manitoba Paper Company, Ltd., subsidiary of the Abitibi Power and Paper Company, has started a 2,000,000 dollar expansion programme at its Pine Falls Mill, Pine Falls, Manitoba. The programme calls for a new groundwood screening system, sulphite screening system, bull screening system, new bark drum and hot pond building, new refuse handling system, new grinder line and a 60ft extension to the boiler-house to contain two new boilers. The Pine Falls mill is the only newsprint plant in the Prairie Provinces.

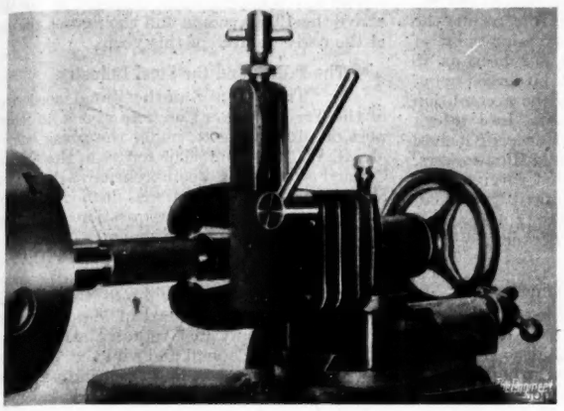
Sulphuric Acid Plant

Canadian Industries, Ltd., is now constructing a 1,000,000 dollar sulphuric acid plant in Hamilton, Ontario. Embodying the latest developments in acid manufacture, the new acid factory will resemble in many ways an outdoor laboratory when completed early next year. Building design calls for the erection of all working parts completely outdoors. Centred among the array of storage tanks, processing vats, criss-crossing pipes and power equipment, there will be only one small building for production control. This development includes a number of advantages among which are economy of construction costs and speed of plant erection. In addition to making acid, a feature of the new works will be its self-contained power system. Sufficient steam will be generated in processing sulphur to carry on power operations, thus dispensing with the need for other fuels. Raw sulphur transported to the plant will be processed by elaborate refining methods and the acid shipped by tank cars to all parts of the country. Daily output of acid will amount to about 200 tons.

A Knurling Tool

In order to avoid the risk of straining the cross-feed screw or other parts of a lathe when engaged on knurling, W. H. Marley and Co., Ltd., 105, High Road, London, N.11, has developed a special tool which involves neither the machine nor the work in any more than the normal turning strain. This tool is also useful where the nature of the component being knurled is such that it would not stand the pressure of a knurling wheel on one side only.

As will be seen from the photograph which we reproduce, the knurling wheels of the new



KNURLING TOOL IN OPERATION

tool are arranged diametrically opposite over the work, which is supported on the back centre of the lathe, and no strain is transmitted beyond the attachment.

The tool is of heavy all-steel construction, the two jaws carrying the knurling wheels being pivoted in a box form housing. This housing has a lug designed to fit any open-sided toolpost with a ½in wide opening. By using an adaptor the tool can be made to fit any American type toolpost which will receive a shank 1in by ½in. The two jaws are coupled together at the centre by an adjustable screw-fed slide, which opens the knurling wheels from 0in to 4in. The slide is provided with a lock-nut to hold a setting when a large number of workpieces are to be knurled. The pivot of the upper jaw is cam operated by a lever, and when the jaws are screw fed to the surface of the work, light movement of the lever towards the operator closes the jaws very slightly, but with considerable pressure. The mechanism is rigidly held by the housing against side movement, but is free to float in the vertical direction, thus enabling the wheels to follow any irregularities in the work. This floating movement is effected against a spring load, whilst the cam handle is designed to remain in the set position during knurling. If required, the attachment can be dismantled and reassembled to give an opposite hand effect for mounting on a toolpost behind the work.

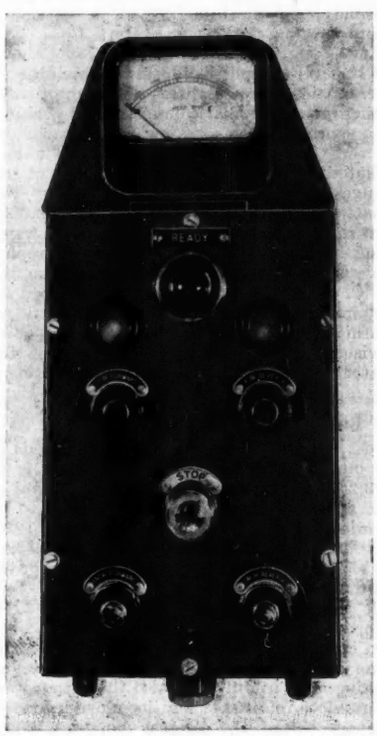
Electronic Motor Control

An interesting innovation in variable-speed electric motor drives is the electronic motor control system that has been developed by Philips Lamps, Ltd., Century House, Shaftesbury Avenue, W.C.2, to provide flexible and stepless speed control of standard d.c. shunt-wound motors.

Briefly, the control system uses the grid-controlled d.c. output of a hot cathode mercury arc rectifier to supply the armature and field of the shunt motor. The voltage applied to the armature and the field current are therefore both independently variable by applying grid control to the rectifiers, so that the equipment is evidently capable of exercising the widest possible control over the motor speed. The required control voltage for the grids is applied through the medium of an electronic control unit. All that the operator has to do is to turn a small knob on the control panel to the setting that corresponds to the desired speed. Any movement is transmitted to the control unit which affects the grid controls in such a way as to bring the motor quickly to the desired speed, maintaining that speed irrespective of load.

Various arrangements for initiating control can be incorporated in the panel. For example, in the equipment illustrated herewith push buttons are used for starting and stopping. The speed control knob can be set to the required speed before starting; on pressing the start button the motor will then run up to the pre-selected speed. A characteristic of the design is that, during the acceleration period the current is held constant by the control unit at a predetermined maximum value, so that the acceleration is constant as long as the load torque is constant. For quick stopping a dynamic braking resistor is used with full field excitation.

Rapid reversal of the motor is also possible, and when this feature is required a reverse push button is provided. This button can be pressed when the motor is running at full forward speed, the effect of this operation being to decelerate the motor rapidly, bringing it smoothly to rest, and then to accelerate the motor in the reverse direction to its original speed. If required a separate speed setting knob can be fitted for speeds in reverse, which predisposes the motor to be run up to a different speed

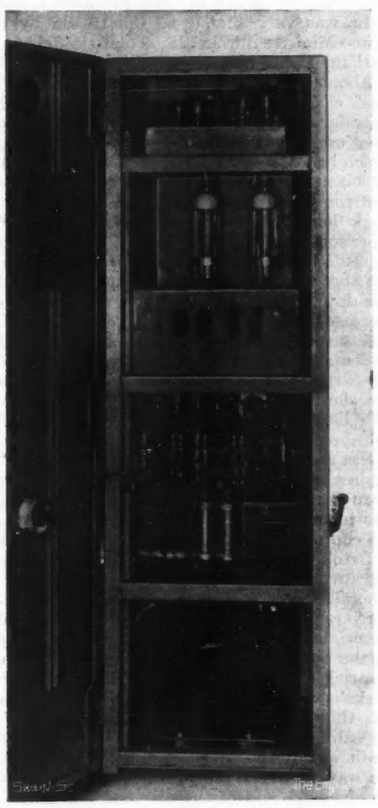


FRONT VIEW OF CONTROL UNIT

upon reversal without altering the control knob setting during the process. During the period of deceleration before reversal energy is returned to the a.c. mains through the rectifier, which, in these circumstances, acts as an inverter.

For applications such as setting up machine tools or printing machinery, where inching may be required, the necessary facilities can be provided by fitting additional push buttons. Operation of the inching push button is arranged to cause the motor to run slowly in the forward or reverse direction as required until the button is released. The manufacturer claims that it is impossible to damage the motor by overloading it or by misuse of any of the controls. The control unit is designed to limit the maximum d.c. that can flow. Any attempt to overload the motor beyond the point corresponding to this maximum current will merely cause the motor to be stalled.

As shown in the accompanying illustrations the complete equipment, comprising mains fed transformer, switchgear panel, rectifiers and



REAR VIEW OF CONTROL UNIT

electronic control unit are enclosed in a vertical sheet metal cabinet. The push-button station and speed control knobs are incorporated in a separate unit which is connected to the cabinet by a flexible multi-core cable. For ease of maintenance it is arranged that each unit can be changed separately. It will be seen from the engraving which shows the rear view of the cabinet that the transformer occupies the lowest compartment. Mounted in successive compartments above the transformer are the contactor panel, the grid-controlled rectifiers and the electronic control unit, which is at the top of the cabinet.

From the foregoing description it will be evident that the control system used can be readily adapted to special requirements, such as repetition machining, constant speed reeling, &c. It is claimed that the equipment can be fully stabilised against fluctuations of mains voltage and frequency. Although specific reference has been made only to push-button controls it will be appreciated that control of the motor can also be effected by limit switches or similar mechanically operated switches fitted to the driven machine.

South China's Railways.—A statement attributed to the Director of the Chinese Government Information Service says that during the Sino-Japanese war all the railways in South China were destroyed before or during enemy occupation, but that 1415 miles, or almost two-thirds, have now been restored and are operating despite shortages of equipment and materials.

Industrial and Labour Notes

The Economic Situation

The Lord President of the Council, Mr. Herbert Morrison, resumed on Wednesday of last week his series of Press conferences for the discussion of Britain's economic situation. At the beginning of this conference, Mr. Morrison said that he wanted to give some information about the Government's plans for dealing with the present economic position and about action which was in hand. Apart, however, from reporting the latest export and coal production figures, the Lord President's statement was very similar to that made by the Prime Minister during the economic debate in Parliament just over three weeks ago.

About coal, Mr. Morrison said that up to the week ended August 16th, the total output this calendar year was 121,400,000 tons, or just over one week behind the production target which had been set. That, he thought, was disappointing, but there was still time to catch up, and the Government had asked the miners to work longer hours in order to do so. Mr. Morrison went on to say that it was not only a question of longer hours in the mines, pointing out that an express condition attaching to the five-day week was that the miners should increase their daily stints and that avoidable absenteeism should be cut out. Unfortunately, he commented, in many pits the miners had not yet carried out their bargain. They had taken the shorter hours and the higher wages, but they had not accepted the longer stints or cut out absenteeism. It was no use adjusting hours unless the face-workers did their part. On the subject of coal stocks, Mr. Morrison gave rather more encouraging news. The target, he said, was to build up stocks from 6,000,000 tons at the end of April to 15,000,000 tons by the end of October. Two-thirds of the additional stock had already been achieved, and industrial stocks generally were still increasing, although they were rather patchily distributed and some essential types of coal were in very short supply. At the beginning of August last year, however, electricity undertakings had less than three weeks' coal stocks, but at the corresponding date this year they were up to five weeks' stocks.

Dealing with steel, Mr. Morrison said that credit was due to both sides of the industry for the way in which they had got down to their job since the end of the war and had gone on turning out steel at about the highest pre-war levels in spite of great technical difficulties and particularly shortage of fuel. The Government's target of 14,000,000 ingot tons of steel in 1948 was higher than any achieved before the war. To realise it, depended on several factors, but most of all on further efforts to find enough coking coal for steel making. In reply to a question, Mr. Morrison declined to make any comment on the Government's intentions regarding the nationalisation of the iron and steel industry.

Miners' Working Hours

Discussions between the National Union of Mineworkers and the National Coal Board on a longer working week in the coal mines were continued throughout last week, and as the two parties failed on Wednesday to reach agreement about working extra time in the present crisis, consultation with various members of the Government took place. This consultation was on Thursday of last week, when, according to an official statement, the issues involved were discussed. The union representatives gave an undertaking that the full implications of the five-day week agreement were accepted and that steps would be taken in conjunction with the Coal Board to bring about an increase of stints when this was possible and to bring to an end all restrictive practices. An undertaking was also given to discuss with the Coal Board methods for dealing with habitual absentees, including, if necessary, the application of penalties, and, in addition, to consider the attachment of conditions to the payment of the guaranteed weekly minimum wage in cases where a joint committee of representatives of the union and the Coal Board was satisfied that there had been organised restriction of effort. Again, however, no agreement was reached on the conditions to be attached to the working of extra time.

On Friday last, a special delegate conference of the National Union of Mineworkers was addressed by Mr. Herbert Morrison. The conference considered alternative proposals concerning conditions to be attached to the working of extended hours and authorised the National Executive Committee to continue the negotiations. It seems that a major point of difference in the negotiations has been as to whether, should Saturday work be agreed upon, attendance on six days should be a condition for receiving the bonus payment. In a speech last week-end, Mr. Arthur Horner, General Secretary of the National Union of Mineworkers, said that the miners had offered to give back the six-day week to the Government "as a loan until May, 1948," and to work six and a half hours every Saturday from September until May next year.

Industrial Negotiating Machinery

Reference is made in the annual report of the T.U.C. General Council to the desirability of reviewing the existing machinery for negotiating in industrial disputes. During the past year, seven cases of disputes between unions have been referred to the T.U.C. General Council, and the question of "demarcation" disputes leading to stoppages of work has been discussed with the Minister of Labour. The General Council has expressed its willingness to assist in the settlement of such disputes before they reach the stage where the prospect of ultimate understanding is prejudiced or vital production is seriously delayed. The Industrial Relations Department of the Ministry of Labour, however, will in every case take all possible steps to bring about a settlement before referring the matter to the T.U.C.

At the suggestion of the Minister of Labour, the General Council has also been making an investigation to see if the speeding-up of negotiating machinery is a practical proposition. The report says that a review of this machinery led the General Council to inform all unions affiliated to the T.U.C. that the making of any changes in voluntary negotiating procedure was a matter for the unions and employers' organisations in each industry. As for statutory wage-fixing bodies, such as Wages Councils, replies made by unions to a questionnaire from the T.U.C. did not reveal, it is stated, the need for any immediate and extensive alterations in existing procedure. The National Joint Advisory Council, however, is keeping the matter on its agenda with a view to finding a way of cutting out any unnecessary time lag.

British Overseas Trade

Exports of United Kingdom goods in the month of July reached a total value of £110,269,013, an increase on the June total of over £17,000,000, and the highest figure to be recorded for any month since November, 1920. July imports were valued at £179,248,032, a total £25,400,000 above the peak figure recorded in June, and in fact higher than ever before with the exception of January, 1920. Re-exports in July totalled £4,287,847.

In considering the export figures it must be borne in mind that there were twenty-seven working days in July and also that there was, as usual, a clearance of documents to the Customs before the August holidays. The Board of Trade observes that the export figures for August and September are always lower, and that no repetition of the July figure should be expected before October.

In volume, July exports are estimated provisionally to have been 125 per cent of the 1938 figure. This is the highest volume attained since the war, the best post-war figure previously being 121 per cent in July, 1946. The increase in exports of manufactured goods was widespread in July, and for the second month in succession machinery and vehicles accounted for over 30 per cent of the total. Machinery exports at 66,000 tons showed, in fact, an increase of 72 per cent on the 1938 average. The number of new motor-cars exported, 12,156, was more than three times the 1938 average, and the gross tonnage of exports of new ships was one of the highest reached for fifteen years. Total exports in July of iron and steel, 196,000 tons, remained below the level of a year ago, but were approximately 25 per cent above the 1938 average and the figures running in the early months of this year.

The T.U.C. and the Steel Industry

The seventy-ninth annual conference of the Trades Union Congress opens at Southport on Monday next, under the presidency of Mr. G. W. Thomson. The report of the General Council is, as usual, a comprehensive document, and, in its fourteen sections, deals with many matters affecting industrial questions of the day.

The "Research and Economic" section of the report surveys the part that the T.U.C. has taken, since its last conference, in discussions about the public ownership of the iron and steel industry. At the end of March last, the Minister of Supply met representatives of the T.U.C. General Council and said that, although his plans for the iron and steel industry were not sufficiently advanced for the preparation of a Bill, he had certain proposals on which he would value the opinion of the T.U.C. The Minister's scheme was outlined in strict confidence and discussed, but the Minister was not then in favour of the formation of a T.U.C. advisory committee. In June, following unofficial reports that legislation for nationalising the iron and steel industry was in an advanced state of preparation, the General Council inquired whether the Minister of Supply would be seeking further consultation with the T.U.C.

Another meeting with the Minister took place in the middle of July. It was then stated that a Bill was being drafted, but would not be completed in time for introduction before the parliamentary recess. The Minister also said that the stage had been reached when detailed consideration by the T.U.C. of certain particular matters covered by the Bill would be of great assistance, but he was still reluctant to form an official T.U.C. advisory committee. The General Council's reply was that, whilst an official committee might have certain practical advantages, satisfactory consultation could probably be maintained on the existing informal basis. The Minister indicated that amongst the points on which he wished to consult the T.U.C. were the questions of the establishment of joint negotiating machinery and the payment of compensation to employees adversely affected by nationalisation. Finally, it was agreed that the next step should be a discussion between Ministry of Supply officials and the T.U.C. staff to draw up a list of all points requiring detailed consideration at future meetings.

Among the resolutions to be considered by the Congress next week is one from the Amalgamated Union of Foundry Workers. It deprecates the fact that up to date no scheme for nationalisation of the iron and steel industry has yet come before Parliament, and urges the General Council to make representations to the Government "with a view to the matter receiving the urgent attention it merits."

Engineer Buyers' and Representatives' Association

We have received a report of a meeting held recently in London at which there was formed an Engineer Buyers' and Representatives' Association. It seems that the aim of this organisation is to protect the interests of buyers and representatives in the engineering industry by maintaining their status, ensuring security of their tenure, fair remuneration, and adequate compensation or reasonable notice upon termination of engagement. The organising secretary of the Association is Mr. A. J. Dronsfield, 47, Victoria Street, London, S.W.1.

French Engineering News

(From our French Correspondent)

Paris, August 22nd

Automobile production for May shows decreased activity, the index being 69·2 against 91·7 in April, 89·4 in March, 78·7 in February and 83·5 in January. Out of the 5122 private cars constructed, 512 have been reserved for use in France and 4160 exported, while 1818 utility vehicles have been exported out of the 4720 produced. Cycle production was 32,550 against 36,021 in April, while bicycles fitted with motors are increasing in popularity at the expense of motor cycles.

* * *

The first locomotive constructed by a French plant since the liberation has just left the Franco-Belge workshops at Raismes. It is a 2200 h.p. "P.141" class express locomotive and is one of 200 of this type which are to be constructed in France. Allocations of steel are still said to be insufficient for the work of construction and equipment which the S.N.C.F. has on hand. At the Audincourt Forges, modernisation is envisaged, which will cost about 200 million francs. A mechanised rolling mill for the production of sheet has been ordered from the United States, and the material, which will be received at the end of the year, will be assembled in 1948. The Société Metallurgique de Knutange also has a big programme for modernisation and re-equipment. The first stage will comprise a turbo-alternator and boilers and the installation of ore preparation machinery.

* * *

Inland waterways in the east of France are in need of improvement. Most shipping prefers the canals in the North and some effort is considered necessary to secure a better distribution of canal traffic. In this connection the Monnet plan envisages the reconstitution and modernisation of canal material, including the construction of 900 barges and 500 self-propelling boats, and the replacement of 1000 old wooden boats by 600 barges and 500 self-propelling craft. The canals themselves are also to be improved by increasing the depth of the more important channels, thus increasing the possible load of barges from 280 to 340 tons. The Transport Office for the East has reported that where a start on this work is impossible work on maintenance should be undertaken immediately and that the greatest number of craft possible should be directed to the Eastern canals.

* * *

The situation in cement works is difficult owing to shortage of fuel and many plants have had to close down in the North, the Paris region and Bordelais. There is also insufficient transport available for carrying slag.

During a recent period, although consumption of electricity decreased, calls on reservoirs were so great that thermal production had to be increased, and some thermal generating stations in the Paris area are in danger of running short of fuel. The level of hydro-electric reservoirs corresponds to a total reserve of about 942 million kWh. The mechanical and electrical industries expect to have exhausted fuel stocks by the middle of September, and increased electrical consumption is expected in the autumn. Production of machine tools has risen again after a slight decrease, while production of agricultural machinery has been stabilised.

* * *

The consumption of natural gas in the Saint-Gaudens region is increasing constantly, and the number of distribution pipe lines is also increasing. The 45-km pipe line from Tarbes to Pau, which was ready for service at the beginning of the year, was completed in less than four months. A "Cleveland" machine enabled 500 cubic metres to be excavated daily and the pipe was laid and covered with the aid of a bulldozer even more quickly.

Almost every month a new pipe line is completed, transporting gas at an average speed of over 100km an hour. The Toulouse pipe line will be duplicated and a cross-country pipe line from Toulouse to Bordeaux will be started in 1948.

Notes and Memoranda

Rail and Road

THE Minister of Transport has drawn attention to the provisions of Section 117 of the Transport Act, 1947, which changes the title of the Traffic Commissioners (Road Traffic Act, 1930) to "The Licensing Authority for Public Service Vehicles," and the title of the Licensing Authority (Road and Rail Traffic Act, 1933) to "The Licensing Authority for Goods Vehicles."

NEW SPANS FOR A BRUNEL BRIDGE.—The G.W.R. is soon to carry out a considerable structural alteration to Chepstow Bridge, carrying the Newport–Gloucester lines over the River Wye. The bridge, designed by Brunel in 1852, consists of a 300ft tubular span over the river and three 100ft land spans, 50ft in height, at the south end. The work involves the replacement of the wrought iron land spans carried on the top of cylindrical piers by new steel spans.

SEVERN TUNNEL TRACK RELAYING.—To speed up and facilitate the work of track relaying in the Severn Tunnel, a special vehicle, fitted with two diesel-electric hoists, has been designed by the Great Western Railway, which will enable pre-assembled track to be taken into the confined space of the tunnel and placed into position and old track to be taken out. The vehicle will be built at Swindon and its use is expected to reduce the number of Sunday occupations necessary for maintenance work each winter.

NEW G.W.R. CEMENT CONTAINER.—The Great Western Railway is building seventy-two new specially designed waterproof road-rail containers for the conveyance of cement direct from the factory to the working site. Twenty-six are ready for traffic. It is claimed that they will afford a quicker, cheaper and easier method of transport for large bulk consignments, and will result in a considerable saving in labour. Each container will hold 3½ tons of cement, equal to seventy bags, and will be loaded three to a wagon. A hinged lid is fitted to the top, which can be clamped down after the cement has been poured in. At destination the container will be lifted from the wagon or lorry by crane and the contents deposited on the site by opening two hinged doors which form its base. This new method will be used when 80,000 tons of cement are transported from Rhoose to Rhayader for the construction of the Birmingham Waterworks extension dam. It is expected that 200 tons will be loaded an hour and that 1,600,000 cement bags will be saved.

Air and Water

BRITISH-ENGINED SOUTH AMERICAN JET FIGHTER.—The "Pulque" jet fighter, built by the Instituto Aerotecnico of Cordoba, has recently made its first flight with successful results. This first Argentine jet fighter is powered by a Rolls-Royce "Derwent V" jet-propulsion engine, the production version of which is now cleared for 3600 lb thrust and 180 hours between overhauls.

R.A.A.F. APPRENTICESHIP SCHEME.—The Royal Australian Air Force hopes to institute early in 1948 an apprenticeship training scheme for the training of technical musterings. The plan provides for the enlistment of boys of fifteen to sixteen for three-year technical courses of training as skilled tradesmen. Ultimately, they will become eligible for senior high trade mustering N.C.O.s in the permanent R.A.A.F.

K.L.M. MOVES TO LONDON AIRPORT.—K.L.M. Royal Dutch Airlines is transferring the operation of its London services from Croydon to London Airport (Heathrow) on September 1st. Since the opening of its first Amsterdam-London service in May, 1920, K.L.M. has been using Croydon as its operational headquarters in the United Kingdom, for both passenger and freight services. At London Airport, K.L.M. will occupy a group of buildings located midway between the two main gates of the airport and backing on to the main parking apron.

LLOYD'S REGISTER SCHOLARSHIP.—The Institute of Marine Engineers announces that an examination for the award of a Lloyd's Register Scholarship in Marine Engineering, value £175 a year for three years, tenable at a British University, will be held on May 24 to 28, 1948. Candidates must be British subjects between the ages of eighteen and twenty-one, who have been employed in engineering, either as apprentices or as college students, with the intention of entering upon the profession of marine engineering, and have served at least two years in commercial engineering workshops. Apprentices in H.M. Dockyards are not eligible for the scholarship. Full particulars may be obtained from the Secretary of the Institute, 85, Minories, London, E.C.3.

Miscellanea

IRONFOUNDRY OUTPUT.—The output of iron castings in the United Kingdom in the second quarter of this year amounted to 714,787 tons, which is equivalent to an annual rate of production of 2·86 million tons. This, according to the Council of Ironfoundry Associations, is the highest output which has ever been officially recorded. It has been achieved in spite of shortages of skilled labour and essential materials such as foundry pig iron and cupola coke. The Council says that if these handicaps could be removed, to allow the existing capacity of the ironfounding industry to be fully employed, even higher outputs could be reached.

AMERICAN AWARD TO BRITISH SCIENTIST.—At a ceremony last week at the American Embassy in London, Dr. E. Talbot Paris, Ministry of Supply radar expert, received the American Medal of Freedom, with Bronze Palm. The citation accompanying the award states that "Dr. Paris rendered meritorious service during the period of action in the field of scientific research development. As a physicist in the Ministry of Supply, he was responsible for the development of radar communications and other electronic equipment required for the ground forces of the British Army. He took an active part in establishing the interchange of scientific information with American laboratories, contributing substantially to the development of highly technical equipment."

"ASLIB" CONFERENCE.—The twenty-second annual conference of the Association of Special Libraries and Information Bureaux will be held at the London School of Economics, Houghton Street, W.C.2, on Saturday and Sunday, September 20th and 21st, beginning at 11 a.m. each day. The papers to be presented are: "The Effect of Atomic Energy Developments on Scientific and Technical Publication," by Professor R. E. Peierls; "Punched Card Systems and their Application to Library and Technical Work," by Dr. J. W. Perry, Dr. W. E. Batten, and Dr. G. M. Dyson; and "Format and Efficiency," by Dr. V. E. Parke, Mr. L. J. F. Brimble, and Mr. L. G. Patrick. There will also be a discussion entitled "Both Sides of the Librarian's Desk." It is hoped to hold an exhibition of modern professional literature on Friday, Saturday and Sunday evenings at Canterbury Hall, Cartwright Gardens, W.C.1, and a demonstration of punched card apparatus.

THE SOCIETY OF INVENTORS.—The Birmingham branch of the Society of Inventors is arranging to hold an exhibition of inventions in the late autumn. Manufacturers and private individuals will be able to exhibit, as well as members of the various branches of the Society throughout the country. The main object of the exhibition is to make known to manufacturers and the public the numerous articles and devices that have been developed during recent years. The exhibition will also give inventors some idea of the progress made by other people and bring them into touch with the needs and requirements of both manufacturers and users. To be eligible for exhibition an article must either be patented, protected or of registered design. Intending exhibitors are requested to write to Mr. B. Thornton Clark, 244, Stoney Lane, Yardley, Birmingham, 25, who should receive applications not later than September 15th. Brief details of the article intended for exhibition should accompany the application.

GENERATION OF ELECTRICITY.—The official returns rendered to the Electricity Commissioners show that 2866 million units of electricity were generated by authorised undertakers in Great Britain during the month of July, as compared with the revised figure of 2765 million units in the corresponding month of 1946, representing an increase of 101 million units, or 3·7 per cent. During the first seven months of 1947 the total number of units generated by authorised undertakers was 24,522 million units as compared with the revised figure of 23,246 million units for the corresponding period of 1946, representing an increase of 1276 million units, or 5·5 per cent. The total number of units sent out from the generating stations of authorised undertakers during the month of July, 1947, *i.e.*, units generated less units consumed in the stations by auxiliary plant and for lighting, &c., was 2698 million units, as compared with the revised figure of 2597 million units in the corresponding month of 1946, representing an increase of 101 million units, or 3·9 per cent. During the first seven months of 1947, the total number of units sent out from the generating stations of authorised undertakers was 23,140 million units, as compared with the revised figure of 21,925 million units for the corresponding period of 1946, representing an increase of 1215 million units, or 5·5 per cent.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

British Association

To-day, August 29th, to Wednesday, September 3rd.—Annual meeting in Dundee.

Engineering and Marine Exhibition

To-day, August 29th, to Saturday, September 13th.—London, Olympia.

Incorporated Plant Engineers

Wednesday, September 3rd.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. "Compressed Air Plant," D. Moreton. 7 p.m.

Friday, September 5th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham. Paper, "Earth Moving Machinery." 7.30 p.m.

Tuesday, September 9th.—MANCHESTER BRANCH: Engineers' Club, Manchester. "Construction and Maintenance of the Manchester Ship Canal," P. N. Reed. 7.15 p.m.

Thursday, September 11th.—NEWCASTLE-ON-TYNE BRANCH: Y.M.C.A., Connaught Rooms, Blackett Street, Newcastle-on-Tyne. "Job 99, Pluto," Mr. Alexander. 7.30 p.m.

Monday, September 29th.—LEEDS BRANCH: The University, Leeds. "Lifting Tackle and Appliances," Mr. Platt. 7.30 p.m.

Institute of Economic Engineering

Friday, September 5th.—Cowdray Hall, Henrietta Place, S.W.1. "Personnel Selection: Army Experience in its relation to the Problems of Industry," Colonel B. Ungerson. 7 p.m.

Saturday, September 6th.—Midland Region: Chamber of Commerce, Birmingham. "Planning of Mass Production." J. Troth, 2.30 p.m.

Sunday, September 28th.—Waldorf Hotel, Aldwych, W.C.2. "Reflections on Productivity Assessment," J. Burgess. 2.30 p.m.

Institute of Physics

Tuesday and Wednesday, September 16th and 17th.—The University, Leeds. Conference on Electron Microscopy.

Institute of Marine Engineers

Tuesday, September 9th.—85, Minories, E.C.3. Presidential Address, Sir Amos L. Ayre. Paper: "Steam Pipework Design in Ships." Lieut. (E) P. T. Hoath. 5.30 p.m.

Institute of Metals

Tuesday, September 23rd, to Friday, September 26th.—Annual Autumn Meeting at Glasgow.

Institute of Welding

Thursday and Friday, September 11th and 12th.—Addison Restaurant, Olympia, W. Autumn Meeting. 2.30 p.m. and 5 p.m.

Institution of Heating and Ventilating Engineers

Tuesday and Wednesday, October 7th and 8th.—Jubilee Celebrations.

Institution of Naval Architects

Tuesday, September 23rd, to Friday, September 26th.—Autumn meetings at Portsmouth and Southampton.

Institution of Production Engineers

Monday, September 8th.—LUTON SECTION: Town Hall, Luton. Film Shows. 7 p.m.

Monday, September 15th.—DERBY SUB-SECTION: Art School, Green Lane, Derby. "Motion Study." Miss A. A. Shaw. 6.45 p.m.

Tuesday, September 16th.—WOLVERHAMPTON GRADUATES: Visit to Hobson Aircraft Company, Ltd. 8.15 p.m.

Wednesday, September 17th.—BIRMINGHAM SECTION: James Watt Memorial Institute, Birmingham. "Cold Upsetting and Thread Rolling." T. C. Parker. 7 p.m.

Thursday, September 18th.—GLASGOW SECTION: Visit to Anderson, Boyes and Co., Ltd., Motherwell. 7.30 p.m.

Monday, September 22nd.—COVENTRY SECTION: Great Hall, Coventry Technical College, Coventry. "The Effects of the Change in the H.P. Tax upon Motor Car Production Engineering," Sir Reginald Rootes.

Wednesday, September 24th.—WOLVERHAMPTON SECTION: Wisemore Schools, Walsall. "The Future Development of Machine Tool Design," J. H. Wilkinson. 7 p.m.

Friday, September 26th.—LIVERPOOL SUB-SECTION: Adelphi Hotel, Liverpool. Inaugural meeting and dinner. 7 p.m.

Manchester Association of Engineers

Wednesday, September 3rd.—Visit to the works of Mather and Platt, Ltd., Park Works, Newton Heath, Manchester.

Works Management Association

Friday, October 3rd.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester. Discussion, opened by A. P. Young.

Launches and Trial Trips

NIGERIAN, steam vessel; built by Furness Shipbuilding Company, Ltd., for the United Africa Company, Ltd.; length 415ft, breadth 56ft 6in, depth 37ft 2in, 8000 tons deadweight. Engines, set of "North-Eastern Reheat" superheat triple expansion, boiler pressure 220 lb; launch, August 19th.

Personal and Business

MR. E. JOYCE has been appointed a director of Blackstone and Co., Ltd.

MR. W. J. TYDEMAN has been appointed advertisement manager of *The Machinist*.

SIR G. K. PETO and Mr. C. W. Speirs have retired from the board of the Morgan Crucible Company, Ltd.

THE P.D.N. CASTLE ENGINEERING COMPANY, Ltd., 87, Pembury Road, Tottenham, N.17, has been appointed sole selling agent in London and South-East England for George Clarke Presswork Company, Ltd.

MR. J. W. GARTON has been appointed chairman of the Hoffmann Manufacturing Company, Ltd., in succession to Mr. E. H. Armitage, who has resigned the position owing to pressure of other business. Mr. Armitage remains a director of the company.

HOWARD CLAYTON-WRIGHT, Ltd., announces that its offices and works are now at Wellesbourne House, Wellesbourne, Warwickshire (telephone, Wellesbourne 316). Its associated companies, Harrisflex Bearings, Ltd., and Clayflex, Ltd., have also moved to this address.

THE STURTEVANT ENGINEERING COMPANY, Ltd. announces that its Sutton and Aylesbury offices will be closed from September 5th and that its organisation will return to London on that date with headquarters at Southern House, Cannon Street, E.C.4 (telephone, Mansion House 0533; telegrams, "Sturtevant, London").

Contracts

THE ENGLISH ELECTRIC COMPANY, Ltd., has been awarded by the State Electricity Commission of Victoria a contract for the supply of transformers for the first 220-kV system to be operated in Australia. The contract comprises seven 18,000-kVA type "OFB" single-phase transformers for installation at the Commission's power station at Yallourn, and four 16,666-kVA type "ON" single-phase transformers for the Kiewa No. 4 power station.

Reports on German and Japanese Industry

Limited numbers of copies of the reports of Intelligence Objectives Sub-Committees on German and Japanese Industry listed below can be obtained from H.M. Stationery Office at the prices stated.

No. of report.	Title.	Post free. s.	d.
B.I.O.S.			
1211	Tow-to-Top (Spinnband) Process in German Worsted Industry ...	3	2
1252	German Clock and Watch Industry	3	8
1266	The Testing of Permitted Explosives (Wettersprengstoffe) at the Testing Gallery, Dortmund-Derne and the Experimental Mine, Tremonia Str., Dortmund	0	7
1267	Testing and Safety Precautions in connection with Industrial Explosives	1	7
1285	Coir Mat and Matting Industry in Germany	1	7
1332	German Surgical Catgut Industry	4	2
1335	The Fluorspar Industry in Germany: Mines and Treatment Plants in the Nabburg and Regensburg Districts, Upper Palatinate (Bavaria)	6	2
F.I.A.T.			
933	Reactions of Carbon Monoxide with Acetylene, Alcohols, Cyclic Ethers, to produce Aliphatic Saturated and Unsaturated Acids and Esters	1	7
1008	Losses due to Evaporation and Melting of the Alpine Snow Cover prior to Spring Thaw: Report in German	1	1
1030 and 1031	The Electron Emission of Crystalline Metal Surfaces and its Relation to the Laws of Crystal Structure: Parts 1 and 2: Report in German	3	2
1033	On the Arrangement of the Double Bonds in Hydrindene: Report in German	1	1
1086	An Instrument for Measuring the Lateral Pressure of Monomolecular Films: Report in German	1	7
B.I.O.S.			
JAP/PR/8 ...	Production of Active Charcoal by Nihon Tanso Co., Ltd., Osaka, Japan	0	7
JAP/PR/19	Products and Producing Capacity of Mitsubishi Kasei Kogyo Kabushiki Kaisha (Mitsubishi Chemical Industries, Ltd., Japan)...	1	1
C.I.O.S.			
XXXII-47 ...	Medical and Pharmaceutical Targets in Northern Germany and Holland	17	4
B.I.O.S.			
394	Technical Report on the Ruhr Coalfield.—Vol. III, Appendix 5.—The Technique of Mining in the Ruhr. (This Report has been published separately by His Majesty's Stationery Office as a Ministry of Fuel and Power publication and should be ordered by the title.)...	0	10
1155	I.G. Farbenindustrie A.G.: The Manufacture of Sulphur Dye-Stuffs and their Intermediates at Mainkur...	5	2
1294	Textile Waste Reclamation (Wool, Rayon and Real Silk): Part II	1	1
1295	The Production of Certain Types of Phosphor Bronze, Brass and Light Alloy Castings in Germany	1	1
F.I.A.T.			
912	The Manufacture of Bile Acids from Ox Bile	1	1
1010	A Review of the Design of Submerged Hydro-Electric Power Plants (System Arno Fischer)...	3	6
B.I.O.S.			
JAP/PR/101	Japanese Fishing Areas	2	2
JAP/PR/818	Characteristics of Japanese Naval Vessels' Main and Auxiliary Machinery	2	2
JAP/PR/1452	Metallurgical Examination of Two Japanese 140mm Naval Projectiles	1	7
JAP/PR/1453	Metallurgical Examination of 5in Japanese Naval Projectiles ...	0	7
JAP/PR/1454	Metallurgical Examination of Japanese Army 47mm H.E. Projectiles	1	1
989	Investigation of Targets Connected with the Manufacture of Fibre Building Boards in Germany	12	4
1223	Iron Powders and Sintered Components	9	3
1238	Gas Containers and Pressure Vessels...	7	8
1272	Inorganic Pigments: Synthetic Iron Oxides	6	8
1281	Molten Salt Bath Practice and Salt Bath Design	2	8
1303	The German Shrimp Processing ndustry	3	8
1312	Preliminary Report on Examination and Test of Daimler-Benz 5-ton Goods Vehicle		7
1320	Preparation of Biological Products at Selected Targets in Germany	15	4
1323	The Production of Powdered Iron and Sintered Iron Driving Bands in Germany	10	9
1342	German Optical Mirrors and Reflectors	2	8

B.I.O.S. Information Section, 37, Bryanston Square, W.1, which has at its disposal a considerable volume of information not in a form suitable for general reproduction, is prepared to receive enquiries regarding all problems relating to scientific and technical intelligence on both German and Japanese industry.

Catalogues

GEORGE KENT, Ltd., Luton.—Booklet on ring balance meters for air and gases.

ROBB ENGINEERING WORKS, Ltd., Amhurst, Nova Scotia, Canada.—Catalogue dealing with the "Victory" boiler.

HADFIELDS, Ltd., East Hecla Works, Sheffield.—Catalogue No. 461, dealing with colliery and mining requisites.

DOMINION BRIDGE COMPANY, Ltd., Lachine, Quebec, Canada.—Illustrated booklet entitled "Platework for every Industry."

TURNER MANUFACTURING COMPANY, Ltd., Villiers Street, Wolverhampton.—Leaflet describing the Turner interval timer.

COVENTRY GAUGE AND TOOL COMPANY, Ltd., Coventry.—Illustrated catalogue describing "Matrix" No. 329 and 46 thread grinders.

WELLINGTON TUBE WORKS, Ltd., Great Bridge, Tipton, Staffs.—Brochure on the new standards for gas list steel tubes and tubulars.

DAVEY, PAXMAN and Co., Ltd., Standard Ironworks, Colchester.—Publications on industrial, commercial and domestic boilers and rotary vacuum filters.

MANGANESE BRONZE AND BRASS COMPANY, Ltd., Handford Works, Ipswich, Suffolk.—Publications on "Oilite" self-lubricating bronze and lead bronze; the "Oilite" super-load bearing, powder metallurgy, and "Oilite" sintered metal filters.